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CONTENTS FOR AUGUST, 1936

OF INTERNATIONAL FLAVOR

ENGLAND, this summer, has been the fountain source of much of CHEM. & MET. interest and inspiration. That first international Chemical Engineering Congress held in London under the auspices of the World Power Conference proved a veritable gold mine of information and data on important trends and developments within a profession that recognizes no geographical limitations. Plant visits which a fortunate few made to such great works as those of ICI's at Billingham, shown here, afforded an excellent opportunity to compare the nature and scale of operations with those in this country.

So, the international flavor introduced into CHEM. & MET. in May, continues this month with more detailed accounts of the happenings in England—to be followed next month with an article on our editorial impressions of chemical engineering developments on the Continent.

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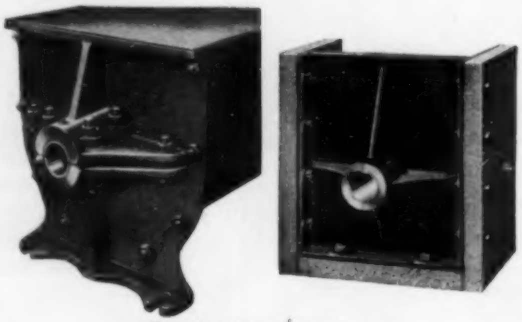

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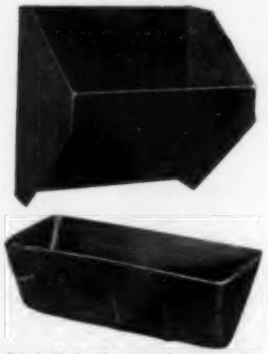

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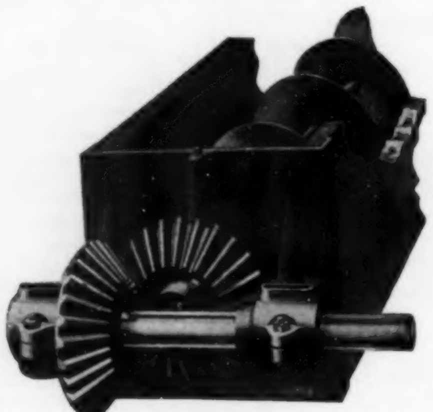

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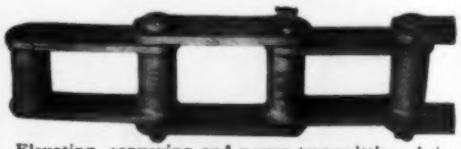

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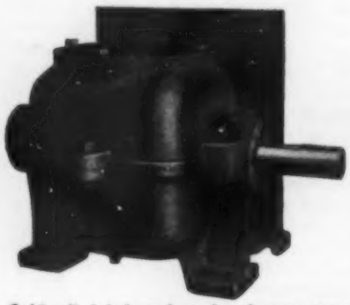

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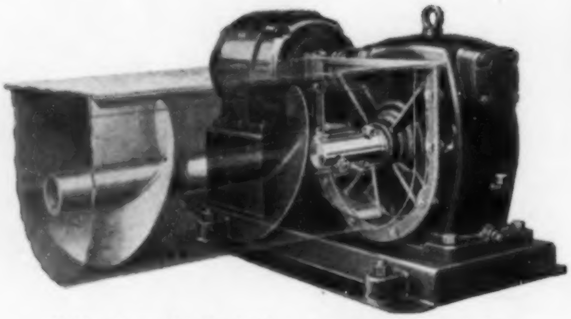

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S. D. KIRKPATRICK, Editor

AUGUST, 1936

NO ROOM FOR SECRECY HERE

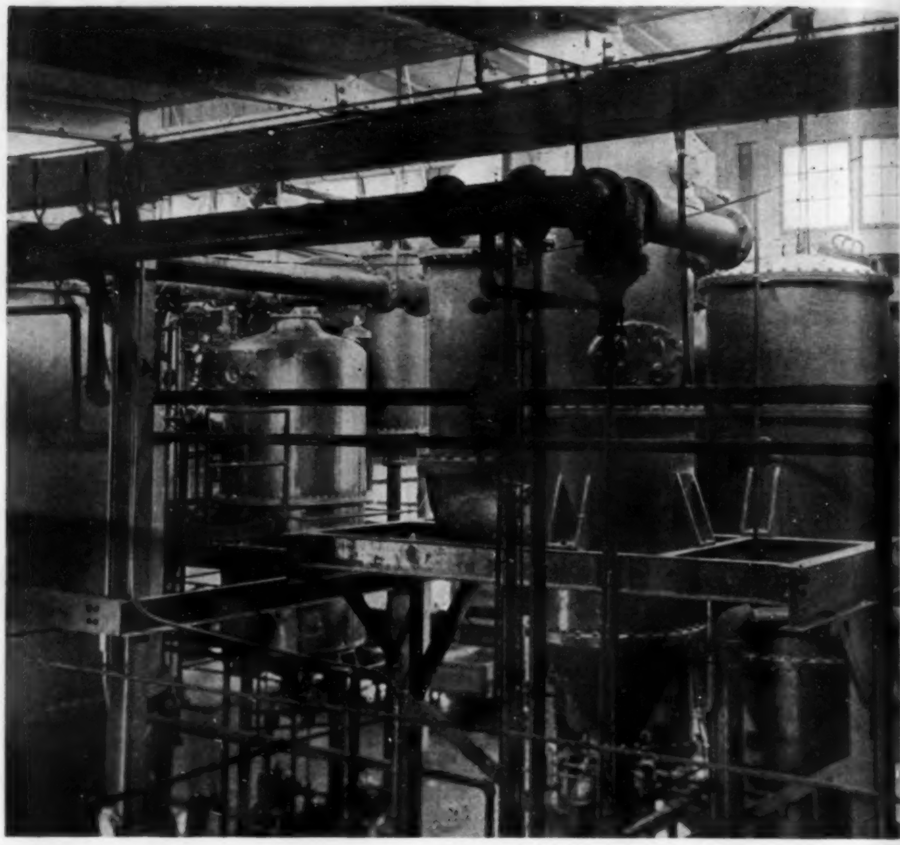
THE RECENT EXHIBIT of protective equipment held in the new Maison de la Chimie in Paris and the plans just announced for a similar section in next year's Achema exposition in Frankfort-on-Main serve to emphasize the increasing international interest in safe practices for chemical industry. Here is a field of activity that makes for cooperation on the broadest possible scale. Fullest exchange of information on methods and equipment will not only prove of direct help in reducing losses caused by industrial accidents, but indirectly, will help chemical industry tremendously in its relation to the public welfare.

One cannot spend much time in Europe these days without getting the impression that the general public regards chemical industry as closely associated with the ever-present threat of war. The average European, whether in England, Germany or France, is inclined to forget the greater importance of the industry's peace-time activities, recalling it only as a potential and therefore dangerous source of destruction. Chemical engineers and industrialists with whom we have talked seem to be on the defensive. As if standing on the brink of an active volcano, they protest that if war comes, it will not be of chemical origin. Rather it will be due to the machinations of politicians and others intent upon stirring up differences between nations. This is undoubtedly true but it does not relieve us of the responsibility for trying to bring about a more favorable attitude toward chemical industry.

One of the best methods by which this can be done is to promote interest in all constructive chemical activities that make for the general welfare. What is being done in our plants to reduce hazards in the manufacture and use of chemicals is worth talking about. There can be no selfish reasons for withholding information that will help others in saving life and property. Likewise what chemical industry as a whole is doing to further the advance of health and happiness for the peace of the world is vastly more important than its necessary but distasteful rôle in the national defense.

Here are at least two bonds of common interest among the principal chemical countries of the world. What we can do individually, as an industry, or as a nation to strengthen these bonds is very much to our advantage. A broad program of cooperation, starting at home and eventually extending to meet similar activities abroad will pay big dividends—not only in international good will but also in the greater satisfaction that comes from constructive rather than destructive achievement.

FROM AN EDITORIAL VIEWPOINT



»What Industry Means to America

A TRUTH distorted, like a picture viewed without perspective, may be calculated to give an entirely wrong conception of easily ascertainable facts. Some of our most popular demagogues thrive on just such practices—and far too often their victim is American industry. On its doorstep are laid a most unsavory variety of accusations—from Technocracy's fallacious philosophy that mechanization was responsible for the depression to the more recent doctrine that "bigness is badness in business" and must be corrected through punitive taxation. Unfortunately industry itself has done little to answer these accusations. Its story has remained untold largely because no one has found a way to dramatize the prosaic facts and figures. This month, however, the editors of *Factory Management and Maintenance* tell the story of "What Industry Means to America" in a special-theme issue that seems certain to stir the imagination and win the honest conviction of the men to whom industry means most—namely, its employees. Unique, colorful charts and brief, terse messages will provide effective ammunition for any chemical engineer or executive willing to take a hand in the battle against the pernicious propaganda of the industrial parasites.

»Spain Upsets Some Markets

SPAIN'S civil war is all too typical of present unsettled conditions in world affairs. Every process industry must take account of these disturbing factors, not only with new market studies, but more importantly with new consideration of modified conditions in supply of chemical raw materials.

An immediate effect of Spanish troubles will probably be a limitation in the supply of iron and copper pyrites and various other ores. Indirectly these changes may affect many units of process industry in the United States. For the sulphur producer there may be new opportunity for markets previously dominated by Spanish pyrites. But to the users of quicksilver there is real threat of elevated prices in the future, should disturbed

conditions in Spain, and Government interference with Italian supply, be continued.

General forecasting is futile; but critical analysis of each company's needs by chemical engineering executives is essential. One should not wait until troubles arrive to calculate means for meeting them.

»Colloidal Fuel May Check Oil Prices

BURNING of more coal in oil-fired industrial equipment is frequently suggested but little practiced. In times of very low fuel-oil prices, the reason is obvious. The powdered coal is not enough cheaper, either when used alone or when used in so-called "colloidal fuel" mixture with oil, to warrant serious study. But these conditions are not likely to remain indefinitely the determining ones.

A recent report on colloidal fuel, presented before the British Institution of Chemical Engineers, gives an excellent summary of economic and technologic considerations that deserve attention. The conclusions of Messrs. Manning and Taylor appear as applicable to American conditions as to British. Those who have responsibility for long-time planning for industrial energy supplies will, therefore, wisely consider the significance of their findings on colloidal fuel, whenever there may be even remote possibility of higher fuel prices. And such time appears to exist just now, with increasing industrial activity and increasing use of motor fuels. It seems altogether appropriate, therefore, that chemical engineers thoughtfully study the report in which these authors conclude:

"There is no reason to believe that colloidal fuel cannot be made to perform satisfactorily as a fuel, even with little or no adjustment to the means at present available for handling liquid fuel. For purposes for which a fuel without ash is required, however, colloidal fuel will be unsuitable, unless some modification of working conditions can be achieved. The phenomena on which the achievement of stability in colloidal fuels depends are now well understood; simple means are available, even if not in the last stage of their development, for assessing the prospects of stability in the colloidal fuel and for adjudging the suitability of an oil intended for making colloidal fuel. Although numerous means have been tried, proposed or indicated for making otherwise unstable colloidal fuels stable, at present the simplest means is probably to select a suitable oil."

»Life Begins at Graduation

THIS YEAR the universities and technical institutions graduated the largest number of chemical engineers on record. Fortunately this increase was accompanied by an unusual demand from the process industries. There were many competitors for each of the more promising engineers in the classes. This situation is not an unhappy one except for the fact that such popularity may give the neophyte a false impression of his own importance in the industrial world. He may assume that the diploma is proof that he has acquired complete knowledge of engineering when in reality he is only beginning his studies.

To keep abreast of the day's progress it is necessary for the young engineer to lay out a program of self improvement and development. Too many never learn to sell their services and ideas until too late in life. So it behooves the young man on whose diploma the ink is barely dry to realize that while the future undoubtedly offers wonderful possibilities, they will be attained only by those men willing to prepare for them today.

Electric furnace No. 2 from operating floor, with combustion chamber at left

Operating Observations at T. V. A. Fertilizer Plant

By HARRY A. CURTIS and ARTHUR M. MILLER

Respectively, Chief Chemical Engineer, Tennessee Valley Authority, Knoxville, Tenn., and Fertilizer Works Manager, Wilson Dam, Alabama

Production of phosphoric acid by the electric furnace method and the manufacture of a concentrated superphosphate in the Tennessee Valley Authority's plant at Wilson Dam, Alabama, have been described in two articles previously published in *Chem. & Met.* (1935, June, p. 320; Sept., p. 488). The present article submits a summary of production results and discusses the operation of various pieces of plant equipment. Another article, now in preparation, will present estimates of the cost of producing triple superphosphate by the electric furnace method.—Editor.

CONSTRUCTION of the electric furnaces at the T.V.A. phosphoric acid plant was described in June, 1935. Electric furnace No. 2 was put into operation on November 7, 1934. Due to faulty meter readings, it was brought up too quickly to full load, with some damage to the retort lining. It was shut down on March 11, 1935, to repair the lining, and was put back into operation on April 2, 1935. It was then operated until October 1, 1935, when it was again shut down for lining repair. Although this repair required a period of only three weeks, the furnace was not again put into operation until January 23, 1936. It has been in operation continuously since that time until the present (May, 1936).

Electric Furnace No. 1 was put into operation on January 13, 1935, and operated until August 12, 1935, when it was shut down for lining replacement. This furnace was not again put on the line until January 8, 1936. As in the case of No. 2, it has since been in continuous operation to the date of writing.

During the first seven months of 1935, there was produced approximately 20,345 tons of triple superphosphate, a part of which was distributed to Agricultural Experiment Stations and to farms where readjusted farm management systems are under test. The balance of the product was stored.

What to Do With Phosphate Fines

When brown phosphate plate rock carries less than about 10 per cent of moisture, it may be crushed readily in any of the usual types of rock crusher. Rock mined during the rainy season and shipped directly to the plant will often carry as much as 20 to 25 per cent moisture. Such rock is spongy and will not pass through a jaw or gyratory crusher. A toothed-roll crusher has been found the most effective means for breaking this spongy rock to — 2 in. pieces for use in electric furnaces.

Whether wet rock or dry rock be crushed, there will be a large portion of fines formed, ranging from 25 to

40 per cent. In a plant producing concentrated superphosphate by the electric furnace method, the rock used in the ordinary electric furnace may run from about $+\frac{3}{8}$ to -2 in. sizes, and the charge should be as free from dust as possible. Of the total raw phosphate used, somewhat more than two-thirds of the phosphate normally goes to the furnaces and somewhat less than one-third to the superphosphate plant. If more than about 30 per cent of fines ($-\frac{3}{8}$ in.) is produced in the crushing, drying, screening and conveying of the phosphate rock received at the plant, there will be an accumulative excess of fines. At the T.V.A. plant, the excess of fines has been reduced somewhat by admixing of various proportions of purchased sulphuric acid with the phosphoric acid. The P_2O_5 content of the superphosphate is, of course, reduced. The somewhat lower grade product is shipped to points of consumption nearest the plant where the freight penalty is least.

It is, of course, possible to agglomerate the fines by various means, such as sintering, and several schemes have been tried out experimentally. Also, an experimental electric furnace (200 kw.) has been developed which will operate with a charge made up of phosphate fines, sand and small coke. A sintering unit, preferably located at or near the phosphate mining operations, is probably at present the most satisfactory means of agglomerating the excess of phosphate fines normally recovered from a brown phosphate deposit. A part of the cost of sintering is offset by the saving in freight on the dry product shipped.

Air Leakage Into the Furnace

A phosphate reduction furnace is necessarily of the closed type. Air leakage into the furnace is highly undesirable for a variety of reasons. The problem is to reduce the air leakage to a minimum.

The first step in accomplishing this goal is to keep the gas pressure in the furnace as nearly zero as possible. It is, however, a practical impossibility to keep the draft exactly balanced against atmospheric pressure, and in order to establish tolerable working conditions around the furnace the pressure must be slightly below atmospheric. Faced with this fact, the next step is to make the furnace as tight against air infiltration as is possible. If the furnace charge be fed into the furnace through open hoppers around each electrode, the situation is hopeless. The electrodes should enter the furnace through deep stuffing boxes or some other method adopted to reduce air leakage to a minimum at these points.

The furnace charge may be fed into the furnace through long closed spouts from overhead bins, the spouts being kept always full of furnace charge so as to afford a reasonably satisfactory seal against air leakage through the incoming charge.

Electrode Breakage a Serious Problem

An electrode in a phosphate reduction furnace is gradually consumed at the lower end, and must be lowered into the furnace as it burns away. This requires that new sections of electrode be added from time to time at the upper end. The commonly used method of doing this is to thread both ends of the electrode section with inside threads. The sections are then joined by a short pin carrying external threads. The joints between sections are weak places in the electrode. So far as the writers are aware, there is no method known by which such joints may be made as strong structurally or as conductive electrically as the body of the electrode elsewhere.

When an electrode breaks, as it will do, occasionally, it invariably breaks at a joint, and almost always at a joint which has passed into the furnace. It is therefore of fundamental importance that the furnace roof be so designed that the broken-off end of an electrode may be reached and hauled out of the furnace.

Obviously joints should be made up with utmost care, using a "joint compound" to improve electrical contact between sections and with precautions not to impair

Tapping No. 2 phosphorus furnace in T.V.A. fertilizer plant

what structural strength the joint may have at best. Next in order is to minimize stresses on the electrode. The furnace charge should be so distributed in the furnace as to avoid side thrusts on the electrodes, which means feeding the charge at several well chosen points in the furnace roof. In any event, the uneven settling of the charge in the furnace will set up side thrusts which tend to tilt the electrodes from the vertical. This tilting must be avoided, and therein arises another difficulty. If the upper end of an electrode be held in a rigid clamp, breakage arising from side thrusts in the furnace is inevitable.

The best arrangement appears to be a guide for each electrode, the guides not being too rigid, but still serving to keep the electrodes approximately vertical. And, of course, there must be sufficient clearance in the stuffing box around the electrode, and sufficient "give" in the packing, to prevent binding at the packing gland.

Electrically speaking, the joint in an electrode is also a source of trouble. In spite of all precautions, and the use of joint compound, the pin will carry more than its share of the current and therefore will become hotter than the body of the electrode. The electrode is therefore hotter at the joint than elsewhere. If the joint is worse than usual, it may become so hot that oxidation sets in at the surface. As the joint "necks down," a still heavier electrical load is placed on the pin, to say nothing of the weakening of the joint structurally. And the hotter the pin, the hotter the joint, and the more rapid the "necking down" and weaker the joint until eventually the joint may not be strong enough to withstand the normal side thrusts in the furnace. Encasing the carbon electrodes in thin metal shields serves to reduce materially the oxidation at the surfaces of the joints, but increases somewhat the cost of operation.

The current density in the electrode is, of course, the determining factor in the heating of the electrode. Vendors of electrodes are apt to recommend too high a current density, such as 30 amp. per square inch of electrode cross-section. With electrodes 30 in. in diameter, a current density of 24 amp. per square inch has been found to be most satisfactory. Operation at 26 amp. has been fairly successful, but at 30 amp. there is constant trouble.

In the early days of operation at the T.V.A. Fertilizer Works, electrode breakage was not uncommon. Today it is a minor difficulty. The electrode consumption, including breakage, has been reduced from nearly 50 lb. per ton of P_2O_5 charged to the furnace to 23 lb. This improvement has resulted from repeated changes in furnace roofs, better distribution of furnace charge, better stuffing boxes, electrode guides, and metal cases on the electrodes.

Tapping the Furnaces

Both periodic tapping of the slag and continuous tapping have been tried. With the latter, the furnace is cooler and heat losses reduced; the labor cost of tapping is also reduced. There are, however, some disadvantages to continuous tapping. For one thing, the formation of crusts in the furnace charge or on the furnace walls is favored by continuous tapping. Also, the erosion of the tapping spout is increased by the continual flow of very hot slag over it, and repairs are difficult to make even after plugging the furnace.

The preference of the furnace operators is intermittent tapping, and this practice is being followed at present.

Every line carrying either burned or unburned gases from the furnace to the hydrator should be provided with means for cleaning which can be operated without opening the lines. The gases leaving the furnace always carry some dust, and since some air leakage into the furnace is almost inevitable, there will be present in the lines a little metaphosphoric acid. This will settle in the lines along with some of the dust, and will sooner or later plug them if not removed periodically. The lines carrying burned and partially cooled gases may be cleaned by flushing with water.

Burning the Gases

The flame temperature of this mixture of gases is extremely high. Furthermore, once P_2O_5 has been formed, it must not be allowed to contact hot refractories, for P_2O_5 will react with nearly all of the ordinary refractories if the temperature be high enough. Relatively thin refractory walls, cooled externally or otherwise, will withstand the attack of the hot gases.

The combustion chamber may be built vertically above the hydrator and continuous with it, but this results in rather a high and costly supporting structure. At present a vertical combustion chamber alongside the hydrator is being used in one of the acid systems, the combustion chamber floor sloping down into the bottom of the hydrator. The steel shell of the combustion chamber is externally cooled and a large excess of air used in combustion. In the other acid system, a horizontal combustion chamber is used, the walls being protected by water-cooled metal tubes which remove about 40 per cent of the heat liberated.

An electric furnace drawing 5,870 kw. will produce gases carrying phosphorus equivalent to about 1 ton of phosphorus pentoxide per hour. As a first approximation, consider that the reaction in the furnace is only the reduction of tricalcium phosphate by carbon. The weights of carbon monoxide and phosphorus delivered per hour would be about 1,972 lb. and 873 lb., respectively. The volume ratio of the gases (assuming the phosphorus gas molecule to be P_4) would be ten CO to one P_4. Actually, the phosphate rock used is not tricalcium phosphate and the coke is not carbon, and the reaction in the furnace is not limited simply to the one assumed above. In practice, the furnace gases will carry relatively a little less phosphorus and a little more carbon monoxide than calculated on the assumption of the simple reaction.

Not only is the flame temperature of such a mixture of phosphorus and carbon monoxide extremely high, but the quantity of heat liberated in the combustion chamber is large, more than 21 million B.t.u. per hour above a datum room temperature.

Initial cooling of the products of combustion must be accomplished by use of excess air if refractories are to

stand the service required. When combustion is complete, fine sprays of water may be used for further cooling. Inasmuch as it is practical to hold the precipitator outlet temperature above the dew point of the steam in the gas stream, and thereby take advantage of the large latent heat of evaporation of water for the purpose of getting heat out of the system, it is obvious that the excess air used for cooling should be held at the practical minimum and as much of the cooling as is possible accomplished by means of water sprays. At best, it is necessary to use an excess of air, which increases the volume of gases that must be handled by the precipitator, and therefore increases the cost of the precipitator.

It is obviously uneconomical to waste the heat of combustion of both the phosphorus and the carbon monoxide, but such is current commercial practice. Since construction of the electric furnace plant for production of a concentrated fertilizer, entirely feasible methods have been explored in the T.V.A. chemical engineering laboratory for utilization of nearly all of the heat now wasted. However, in the plant now under discussion, the problem is to waste the heat as economically as possible.

Corrosion Problems in the Plant

Chemical corrosion is an ever-present problem in a phosphoric acid plant. The corrosive action of the slag in the furnace has been mentioned above. When the gases issuing from the furnace are burned, phosphorus pentoxide and some metaphosphoric acid are formed, and both are at high temperatures. In the No. 2 Acid Plant, about 40 per cent of the heat of the combustion is removed by water-cooled tubes hung along the side-walls of the combustion chamber. Metaphosphoric acid, contaminated with silica, rock dust, etc., promptly condenses on these and runs down onto the floor of the chamber. The cooling tubes are exposed to rather severe corrosion. Tubes of ordinary steel, of several kinds of stainless steel, of copper, (plain and deoxidized), of brass (several kinds), of cast iron, of Duriron, of bronze, of graphite, etc., have been tested. The tests are still in progress, but it appears probable that the cast iron tubes will give the cheapest service, life of the tubes and original cost considered.

Lead has proved a satisfactory material for the lining of wooden tanks handling cold concentrated (+75 per cent) phosphoric acid, and for backing acid-proof masonry in steel containers. It fails rapidly in contact with hot phosphoric acid.

Duriron has proved fairly satisfactory for acid lines carrying warm concentrated phosphoric acid, but fails in the scrubbers where the waste gases are washed prior to discharge, due, possibly, to the presence of hydrofluoric acid.

In the precipitators, the lead tube sheet at the top end of the tubes failed through corrosion. The carbon tubes themselves show no signs of deterioration. For electrode wires, silver, tantalum and molybdenum stainless steel have been tried. Silver wires fail too frequently; tantalum wires are durable, but too high in cost; molybdenum stainless steel wires are the most economical so far as present experience goes.

Another kind of chemical corrosion results from the fact that the hot phosphorus pentoxide reacts with practically every refractory oxide. Every brick carrying alumina, lime, magnesia, iron oxides, or any other metal base oxide will react with the hot phosphorus pentoxide to form metaphosphates of relatively low melting points, if only the temperature at which contact occurs is high enough. In the No. 2 Acid Plant the cooling tubes along the walls of the furnace afford protection to the walls behind them. In the No. 1 Acid Plant the gases are burned downward in a refractory-lined tower. The refractory lining slags off until its thickness is such that the rate of heat transfer outward to the water-cooled steel shell of the tower lowers the temperature of the refractory below its reaction temperature. A very dense brick is desirable as a refractory, in order that penetration of the hot phosphorus pentoxide gas may be a minimum, and the heat conductivity high. No refractory yet tried will withstand the attack of the hot phosphorus pentoxide unless provision be made to carry the heat rapidly away from the refractory and thereby hold its temperature down.

The warm concentrated phosphoric acid coming from the hydrators and precipitators was originally received in lead-lined troughs and ran by gravity to settling tanks. The lead linings failed within a few weeks, after which the troughs were lined with acid-proof masonry.

The settling tanks extend below ground level. They are of concrete, lined with several layers of asphalt and tar-paper, then with chemical lead, and finally with acid-proof masonry. It was originally planned to use these tanks to clarify the phosphoric acid by allowing the sediment to settle. Subsequently it was decided that it was better to keep the sediment suspended in the acid and to allow it to go on into the superphosphate, rather than to create an unnecessary problem of sludge disposal. The settling tanks therefore serve only as catch tanks at present.

Lead-lined steel piping was at first installed to carry the somewhat warm concentrated phosphoric acid from the catch tanks to storage. These failed after a few weeks service. They were replaced by Duriron lines, which have proved to be satisfactory.

The pumps for handling the warm concentrated phosphoric acid are of cast molybdenum stainless steel and have given satisfactory service. It should be emphasized that molybdenum stainless steel should have a low carbon content (carbon less than 0.07 per cent) if it is to be used in handling phosphoric acid.

Byproduct Materials

A phosphate smelting furnace operating on Tennessee brown phosphate rock will produce a little over 0.7 tons of slag for each ton of phosphate rock plus silica pebble fed to the furnace. If this slag be cooled slowly in chill cars it does not shatter badly, and, on crushing and screening, makes excellent material for concrete aggregate or road construction.

The slag as it flows from the furnace may be blown readily into slag wool. Inasmuch as the slag has a very low value, and the cost of melting may properly be

charged elsewhere, the manufacture of slag wool should be a profitable operation in conjunction with such a furnace operation.

A typical slag analysis is as follows:

	Per Cent
CaO	48.2
SiO_2	40.9
P_2O_5	1.8
Fe_2O_3	0.8
Al_2O_3	4.5
F	2.8
S	0.2

The iron compounds present in the phosphate rock, silica pebble, and coke are reduced in the electric furnace. The iron absorbs a little silicon and much phosphorus, forming a product known commercially as "ferrophos." At present the "ferrophos" may be sold for more than the potential value of the phosphorus considered as a raw material from which to produce triple superphosphate.

A typical analysis of the "ferrophos" produced is as follows:

	Per Cent
Phosphorus	25.8
Silicon	0.7
Manganese	1.8

Triple Superphosphate Manufacture

Mixing of the raw phosphate dust and concentrated phosphoric acid is done batchwise in a sigma-blade type of kneading machine. A mixing period of less than two minutes suffices. The product is dumped out of the mixer while in a moist, crumbly condition. It is carried on a pan conveyor to an elevator and thence by monorail dump car to the storage pile. By the time the triple superphosphate reaches the storage pile, less than ten minutes after mixing, it is in granular condition and relatively dry. It cures very rapidly and the bulk density as shipped is somewhat higher than that of triple superphosphate made by the older processes.

It has been found that concentrated sulphuric acid may be mixed with the phosphoric acid up to about 20 parts of sulphuric per 100 parts of phosphoric and used in the same mixing and handling equipment. The superphosphate is slightly sticky when first made, however, and requires that the conveyor and elevator be cleaned out occasionally. Aside from this, the conversion of the phosphate in the raw dust falls off and in spite of the lower cost of the sulphuric there is no economy in its use in mixture with phosphoric.

Operating Records

Although the plant as a whole has been in operation continuously for periods of several months, experiments of one sort or another have been in progress all the time, and these have somewhat upset the operation records, so far as significant production data are concerned.

For the present discussion, the operation of Electric Furnace No. 2 for the months of February, March, and April, 1936, will be taken as typical, there being a minimum of experimental work interfering with the furnace operation during this period.

Operating Data, Furnace No. 2, 90 Days

Power on furnace, per cent of total time	98
Average power load on furnace, kw	5,330
Phosphate rock charged, 90 days, tons	6,816
Average P_2O_5 in rock, per cent	32.47
Silica pebble charged, 90 days, tons	2,016
Average SiO_2 in silica pebble, per cent	96.5
Coke charged, 90 days, tons	1,258
Average fixed carbon in coke, per cent	82.7
Average overall recovery from P_2O_5 in rock to P_2O_5 in acid, per cent	86.8
Slag produced, 90 days, tons	6,235
Average P_2O_5 in slag, per cent	2.0
Average phosphorus in ferrophos, per cent	25.5
Electrode consumption, 90 days, lb	50,787
Average power consumption per ton P_2O_5 charged to furnace, kw.-hr	5,092
Average power consumption per ton P_2O_5 recovered in acid, kw.-hr	5,869

The power consumption in the furnaces is about 90 per cent of that required for the whole fertilizer plant, from raw materials to finished triple superphosphate bagged for shipment.

The phosphate dust used with the phosphoric acid in manufacturing triple superphosphate is of somewhat lower grade than the lump phosphate used in the furnaces, averaging (3 months, February-April, 1936) 27.8 per cent P_2O_5. The triple superphosphate as shipped after a few months storage carries about 45.6 per cent total P_2O_5 equivalent, with an "available" P_2O_5 equivalent of about 43.2 per cent.

The coal required for drying the wet phosphate rock, coke and silica varies considerably with the season. For a three months period (February-April, 1936) it averaged 226 lb. per ton of rock charged to the furnaces, and 552 lb. per ton of total P_2O_5 in the superphosphate.

From the above operating data, the following may be derived:

Summary of Operating Data on Phosphoric Acid Production

Item	Per ton P_2O_5 in rock to furnace	Per ton P_2O_5 in acid
Power for furnaces, kw.-hr	5,092	5,869
Electrode consumption, lb	23	26
Silica pebble for furnaces, lb	1,822	2,100
Coke for furnaces, lb	1,136	1,310
Slag produced, lb	5,634	6,494
Phosphate rock for furnace, lb	6,160	7,096

The typical distribution of phosphorus in an electric furnace plant operating on brown phosphate rock of 32.77 per cent P_2O_5 and 3.33 per cent Fe_2O_3 is as follows:

	Per Cent
In slag	5
In ferrophos	6
Stack losses	2
In acid	87
Total in rock used	100

It will be noted that in the three months operating period mentioned above (February-April, 1936) the recovery of P_2O_5 from rock to acid was 86.8 per cent as against a practical limit of 87.0 per cent.

The P_2O_5 in the slag and in the stack gases is, of course, a total loss. In the ferrophos, however, the value of the phosphorus is usually more than its value in phosphoric acid.

Chemical Engineering Receives International Recognition

By S. D. KIRKPATRICK
Editor of Chemical and Metallurgical Engineering

CHEMICAL engineering came into its own on an international scale as one result of the first Chemical Engineering Congress of the World Power Conference which, as most *Chem. & Met.* readers must know by this time, was held in London, June 22 to 27. Eight hundred delegates representing more than thirty of the principal industrial countries of the world assembled in Central Hall in Westminster for discussion of common problems and policies as presented in more than 125 professional papers. The simultaneous exhibition of the British Chemical Plant Manufacturers' Association and a brilliant social program of luncheons, banquets and official receptions made the week a memorable one, especially for the members of the American delegation.

The Duke of Kent, who officially opened the International Chemical Engineering Congress in London, poses with its president, Lord Leverhulme (at left) and Sir David Milne-Watson (in center), chairman of its organizing committee.

(Photos supplied through courtesy of CHEMICAL AGE)

Great Britain with 450 registered members quite naturally dominated the conference, but as gracious and experienced international hosts, every facility was provided to encourage the active participation of overseas delegates. Next to the United States with more than 100, the largest foreign delegation was from Germany with 44 registered members. Japan followed with 29, then Holland and Sweden with 13 each, Switzerland and Denmark with 9 each, France and Russia with 8, Belgium with 7, Poland with 6, etc., on down through the list to the 1-man delegations from Anglo-Egyptian Sudan, Estonia, Finland, Latvia and Roumania. Italy alone among the major industrial countries was missing, but then, of course, sanctions were still in effect.

That chemical engineering is recognized and held in highest esteem in Great Britain was evidenced by the fact that the Congress was officially opened by the Duke of Kent. As emissary of his brother, King Edward VIII, he paid a high tribute to the work of the chemical engineer in enabling chemical reactions to be carried out on a gigantic scale and with precise control and utmost safety for the worker. "Chemical engineering," he said, "is one of our most modern professions, already so successful in meeting the needs of mankind as to make it impossible to set any limitations on its achievements in the future."

Like recognition of the importance of the role of the chemical equipment manufacturer was given by the Rt. Hon. J. Ramsay MacDonald, Lord President of the Privy Council, who officially opened the British plant exhibition on June 22. All available space on the ground floor and basement of the hall had been filled by the exhibits of the British equipment makers and those of the Department of Scientific and Industrial Research. Mr. MacDonald eloquently outlined the British government's great interest in stimulating the application of science to industry. "With new plants, new methods and new technology, the years to come will yield stories in the history of our industrial evolution, just as conspicuous, as wonderful and as miraculous as those written when the steam engine was first used in industry.". He referred to the chemical engineer as the lusty, promising youth to whom industry must look for greater economy in production, arising from ingenious and efficient design of equipment. "There

The Rt. Hon. J. Ramsay MacDonald Addresses Opening Meeting of British Chemical Plant Manufacturers' Ass'n.

At his right sits J. Davidson Pratt, O.B.E. secretary and general manager; at his left, J. H. G. Monypenny, chairman. Among official delegates and guests on the platform sit W. A. S. Calder, president of the Society of Chemical Industry, Herbert Levinstein, president of the Institution of Chemical Engineers, Leo H. Baekeland of the United States, Profs. A. W. Schmidt and Otto Fuchs and Herbert Bretschneider, of Germany.

must be no shoddy work, no slapdash, no assumption of conclusions; care and efficiency are the conditions of enduring work." With his own eyes he had seen, he said, convincing evidence of great and lasting chemical engineering work in the huge plant of I. C. I. at Billingham, which he had had the privilege of dedicating a few months ago.

The Rt. Hon., the Viscount Leverhulme proved a most gracious president of the Congress and his opening address (which appears on pp. 414 and 415 of this issue), received wide and favorable comment. He defined the chemical engineer as "a man experienced in the design, construction and operation of plant and works in which matter undergoes a change of state and composition." This definition appealed to him most, he said, because it exemplifies the essential fact that the chemical engineer is first and foremost an engineer, although, of course, his need for chemical knowledge arises from the fact that the plant he constructs must deal with chemical reactions with which the ordinary civil or mechanical engineer is quite unfamiliar.

Following Lord Leverhulme's presidential address, representatives of the various delegations expressed their thanks to the Duke of Kent and to the organizing committee of the Congress, which was headed by Sir David Milne-Watson, executive head of the largest municipal gas works of the world. Those who spoke included Dr. M. H. Cabelle of France, Dr. B. Mulert of Germany, Prof. Y. Oshima of Japan, Dr. J. Pfeiffer of Holland, Professor N. Ushkevitch of U. S. S. R. and Dr. Martin H. Ittner, president of the American Institute of Chemical Engineers. Incidentally, the last-named gentleman's energetic leadership helped greatly to put the American delegation into a position of influence and authority in its active participation in the affairs of the Congress.

Five full pages of abstracts of some of the principal technical papers appears elsewhere in this issue of *Chem. & Met.* Others will be reviewed or published in extenso at a later date. To one inexperienced in the technique of handling a great international gathering such as this, it seemed at first that it was going to be impossible to crowd these 125 papers into 12 technical sessions, each limited to but 1¼ hours. Fortunately, however, the Organizing Committee had the benefit of the valuable experience gained by the World Power Conference which has led to the development of a plan so unique that it is perhaps worthwhile to outline it briefly here.

For each of the 12 subject sessions or symposia there had been appointed a general chairman (from overseas) and a vice-chairman (British), as well as a general reporter (British). After a brief introductory statement of five minutes or less by the chairman, the general reporter presented in 10 minutes a critical report on all of the papers, laying particular emphasis on the points on which further discussion seemed desirable. Then for 55 minutes the meeting was opened for general discussion, but by means of an ingenious system of traffic lights, each speaker was definitely limited to five minutes. The authors of the various papers were on the platform behind the chairman and available for answering questions or participating in the general discussion, but in that regard they shared no better than the most humble member of the audience. Finally there was a brief summing up by the chairman or vice-chairman and the session adjourned, always on time and in time for the inevitable tea or for some, perhaps, an American or German equivalent.

Contrast this arrangement with some of our own prolonged technical sessions where four or five authors are allowed 40 min. or an hour each to read their papers or a dozen authors are given 10 min. each for inadequate abstracts and summaries. To be sure, the British arrangement pre-supposes that the papers have been received in time to have been preprinted, and more important, to have been read by all members in advance of the scheduled meeting. Only in this way can a discussion be confined to pertinent points of general interest to the whole audience. Isn't this something that A.C.S. or A.I.M.E. might well try out someday?

Unfortunately but few of the American delegation had read all of the papers, but that did not keep them from contributing some very constructive comment. Prof. James R. Withrow of Ohio State University, served with distinction as chairman of the opening section on ferrous metals and Prof. A. B. Newman of Cooper Union presided as chairman of the session on heat exchange. Active participants in the discussion included Percy C. Kingsbury of General Ceramics, Prof. Edward Bartow of the University of Iowa, Prof. Walter G. Whitman of M.I.T., Prof. George Granger Brown of the University of Michigan, Profs. Hixson and Morgan of Columbia University, Dr. L. H. Baekeland, president of the Bakelite Corp., and perhaps others who escaped the editorial ears.

In addition to the technical papers, which are abstracted on pages 419 to 423 of this issue, four somewhat more general sessions dealt with chemical engineering education, safety and related administrative problems, development trends and broader aspects of chemical industry. Significant papers such as those by A. H. White, H. W. Cremer, and A. J. V. Underwood on education, F. Martius of Germany on accident prevention, Crosby Field on projects formulation, C. M. A. Stine on fundamental research will be discussed in a subsequent issue.

An interesting comment by Prof. George Granger Brown of Michigan aroused several marked differences of opinion at the educational session. He said he thought the name "Chemical Engineering" put too much emphasis on chemistry and that a better designation would be "Process Engineering" because of the essential importance of physical data and methods and a new, quantitative, critical attitude of mind directed primarily toward the development of new processes. He holds that there is no room in chemical engineering for "handbook engineers," no place for purely descriptive courses nor for any degree of specialization in an undergraduate's four year course.

Brilliant Social Program

Strange as it may seem, the events most of us will probably remember longest about our week in London will not be choice tidbits of technology with which our minds were filled to overflowing during the technical sessions. Rather we will recall most vividly the fact that each night we donned the tophats and tails and betook ourselves to formal receptions and grand banquets where we were wined and dined with all of the traditional pomp and ceremony, exquisite cuisine and excellent liquors that through the centuries have established Britain's enduring reputation as entertainers extraordinary. Despite the feeble protests of those few Americans fearful that they "could not take it," this writer observed few plates untouched or glasses turned down once the procession of waiters got under way.

The annual dinner of the Institution of Chemical Engineers proved one of the most enjoyable of the many social occasions. Members of the American Institute of Chemical Engineers were the principal guests received by Dr. Herbert Levinstein, the well-loved president of the Institution. Lord Leverhulme, Dr. William Cullen, vice-president, and Prof. H. W. Cremer, suave and efficient honorary joint secretary of the Institution, offered toasts to which Dr. Ittner responded for the American delegation. At the official banquet of the Congress, attended by more than 500 members and guests, the principal toasts were those of Lord Rutherford, Sir David Milne-Watson, and the Rt. Hon. Ramsay MacDonald. On this occasion Dr. John Van Nostrand Dorr, as chairman of the American Committee, made a most gracious and eloquent response. His Majesty's government held a reception at Lancaster House in St. James Palace on June 24 at which some 300 guests were received by the Lord President of the Privy Council and his daughter, Miss Ishbel MacDonald. Participating governments were officially represented. On the concluding evening of the Congress a gala party was given by Imperial Chemical Industries, Ltd., in its magnificant office building in Millbank. In the absence in America of Sir Harry McGowan, Mr. Mitchell, newly elected president of I.C.I., received the guests.

As Sir Harold Hartley, chairman of the International Executive Council of the World Power Conference, officially closed the Congress on Saturday, June 27, he called attention to the next scheduled meeting which will be held in Washington, D. C. in September—the third World Power Conference. Many in the audience indicated their intention at this time to pay a return visit to the United States. Sir Harold also announced that an invitation to hold a second Chemical Engineering Congress in 1940 had been received from Berlin. The proposal met with popular acclaim by the meeting, but can be acted on officially only by the International Executive Council of the World Power Conference.

These rambling and entirely inadequate comments would be even more incomplete without a brief reference to the delightful week that followed the strenuous technical sessions in London. More than 100 members of the American delegation, many with their wives and families, joined with a smaller group from the Institution of Chemical Engineers for a week of pleasant holidays spent in the delightful countryside of southern and central England and northern and western Wales. Following the gala dinner on Independence Day in the old Grosvenor House in Chester, the entire party was taken to Liverpool and deposited on the steps of the Midland Adelphi Hotel where was to be officially opened next day the 55th annual meeting of the Society of Chemical Industry. Many members of the American party remained for another week in this great capital of chemical industry in England where again they were royally entertained while their appetites for technology were being satisfied in technical sessions and a very profitable and instructive series of plant visits. Space forbids more than this brief reference to what proved a veritable climax for the three intensely interesting weeks we spent in old England.

Luncheon Meeting at Hotel Victoria Celebrates Opening of British Chemical Plant Exhibition

CHEMICAL ENGINEERING

By THE RT. HON. THE VISCOUNT LEVERHULME
President, International Chemical Engineering Congress

THE CHEMICAL ENGINEER has been defined as a "man experienced in the design, construction and operation of plant and works in which matter undergoes a change of state and composition." Personally I like this definition because it brings out the essential fact that a chemical engineer is first and foremost an engineer, although of course his need for chemical knowledge immediately arises from the fact that the particular plant which he constructs is required to handle materials upon which it will chemically speaking have some affect and which will in turn be affected by them.

Although the term "chemical engineering" has until now only found general recognition in the British Empire and the United States and to a lesser degree in Germany, the spheres of interest into which enter the activities covered by this term are today, both geographically and functionally speaking, almost universal.

Unlike most other branches of engineering, chemical engineering has not developed into a distinct branch of engineering under pressure of specialization, but rather in direct answer to the demands of industry, with which it has from the very beginning of its history been more closely bound up than has any other branch of engineering.

The pioneer work in the field of chemical engineering was mainly carried out in Germany and the United States, and it was not until the changed economic conditions of the War and immediate post-War period had stimulated the manufacture of chemical products of all kinds that chemical engineering began to receive in Great Britain the attention which it merited.

The more recent history of the development of chemical engineering is readily illustrated in the rapidly widening range of industries with which the chemical engineer is being associated.

Based on the presidential address by The Rt. Hon. The Viscount Leverhulme at the official opening of the Congress, Monday, June 22, 1936.

It has rightly been said of scientific method that it is an attitude of mind. The business man of today is far more susceptible to this attitude of mind than was his father or even his elder brother, and consequently he is becoming increasingly receptive to the efforts of the chemical engineer to help him in solving his technical problems.

However, just as this attitude of mind is not to be seen in the conduct of every business, so has industry yet to make full use of chemical engineering knowledge. Nevertheless the extent to which the work of the chemical engineer enters today into the manufacture of articles in common daily use is positively bewildering.

To the layman, did he but know it, the chemical engineer manifests himself in a diversity of ways. He guards his health and his pocket. He is a welfare worker and a preserver of man's greatest heritage—the products of nature. To the layman in his capacity of consumer the chemical engineer is revealed in two ways—in lower price and in improved quality.

In this matter of price the chemical engineer has set new low standards for a considerable range of products. He has achieved this through producing synthetically materials, the high cost of which has in the past greatly added to the price of the finished article. The high cost was sometimes due to nature's inability to produce the material in question in sufficient quantities; sometimes, to the prevalent economic nationalism of our times; and sometimes to both. Whatever the cause the chemical engineer has already in many cases nullified it by the development of substitutes, and will continue to do so to an increasing extent in the future.

Generally speaking, scientific research leads through the elimination of waste to a conservation of resources, and there is no branch of science of which this is truer than it is of chemical engineering. In years to come it will, I think, be precisely for this conservation of our resources that the chemical engineer will receive the greatest recognition from a world wherein the gradual exhaustion of nature's resources is being accelerated by the increasingly heavy demands made upon them.

Scientific progress in whatever field is becoming increasingly complex and the various branches of science increasingly interdependent. Thus when we find, for

FROM A WORLD VIEW

example, that the work of the chemical engineer is becoming more dependent on the development of high-pressure high-temperature technique, we find also that this development is in turn conditioned by the progress which is being made by the metallurgist in the production of metals and alloys better able to stand the strain which high-pressure high-temperature technique imposes upon the modern chemical plant.

I would like to revert for a moment to this problem of high-pressure technique, because I feel convinced that it is along these lines that we are destined to see the most noticeable developments in chemical engineering during the next few years. If I may be allowed to make a suggestion to those of you here who are primarily concerned with chemical engineering in its educational aspects, it is that you should make sure that the coming generation of chemical engineers are pressure minded.

I said at the beginning of my address that having given some thought to the nature of chemical engineering, we ought then to consider why it was that this congress came to be held at all. Let us do so!

Chemical engineering, by whatever name it may be called, is today practiced all over the world, and occupies a position of prime importance in our world economy, but as is inevitable with all applied sciences having such a relatively short history behind them, chemical engineering has developed very unevenly in different countries, both as regards the actual progress which has been achieved and as regards the relative importance which each country places on the various aspects of the science. For these reasons it has long been felt by many people that it was time for the chemical engineer to review his progress and to consolidate his achievements.

The varied development of chemical engineering in different countries meant that this work of revision and consolidation could only be undertaken on an international basis, and it was from this fact that the conception of an international chemical engineering congress gradually emerged in this country.

We shall witness the ultimate realization of this conception during the coming week, and I think that you will agree that the standard of papers presented to the congress bears eloquent testimony to the fact that the subjects which we shall be discussing offer ample opportunity for this work of revision and consolidation.

The idea of holding a chemical engineering congress in London ultimately found practical expression in the initiative of one man—the late Sir Frederic Nathan, a past president of the Institution of Chemical Engineers. One or two of my former colleagues on the Council of the Institution of Chemical Engineers will share my pleasant recollections of lunching with him at his club some four years ago when the conception of this congress was discussed. We remember how keen he was on its being held and what high hopes he had of its results. I am sure that all his old friends will deeply regret his not being spared to see his hopes realized and to witness the success with which his labors have been rewarded.

If it was Sir Frederic Nathan who turned the congress from an idea into a reality, it is the International Executive Council and the National Committees of the World Power Conference to which must go the credit for making the congress the international success which it promises to be. We have had the advantage of the great experience and enthusiastic assistance of the National Committees of the World Power Conference throughout the World in organizing participation by their respective countries. We are proud that this congress is being held under the auspices of the World Power Conference.

However the relation of this congress to the World Power Conference is not purely one of organization. The main purpose of the World Power Conference is to bring together those directly concerned with the power and fuel industries in each country—both producers and consumers—in order to ensure that their problems are considered from an international as well as a national standpoint.

I wish to emphasize that the association of chemical engineering with the World Power Conference is not fortuitous, for the contents of the papers to be read at this congress show what a close relationship exists between them. Are not the energy requirements of a chemical process the fundamental consideration in its translation to a works scale? Then, too, so many of the problems of chemical engineering which we shall be considering have a direct application in the fuel and power industries, and I have no doubt that our discussions this week will make a valuable contribution to the work of the World Power Conference by helping towards the solution of many problems which are its direct concern.

We have tried to offset the cumulative strain, which our discussions may occasion at any rate among the more earnest of us, by introducing a leaven of social functions into the proceedings. However, quite apart from the recreational aspect of the matter, I personally set great store by the social engagements which lie before us. Chemical engineering may be primarily a matter of science, but no human activity, scientific or otherwise, can prosper without that essential lubricant of all human endeavor—cooperation. The basis of cooperation is confidence in those with whom we have to cooperate, and this confidence can only be developed through their better acquaintance.

It is a great pleasure to us in Great Britain to be acting as hosts for this congress. We are, however, fully conscious that this pleasure carried with it great responsibilities, and we shall only consider that our efforts in sponsoring this congress have been successful if, on looking back, we can honestly say that we have, through this congress, made a worth-while contribution to that task of international revision and consolidation with which I feel it such a great privilege to be associated.

Extraction of Phosphatides From Soybeans

By A. A. HORVATH

Chemist, Agricultural Experiment Station, Newark, Delaware

THE CURRENT TREND in soybean oil milling in the United States is toward a replacement of the old pressure method by the more recently developed solvent extraction process. One of the most significant results of this change has been the opening of a new source of vegetable phosphatides, complex organic substances which are valuable commercially for their emulsifying and antioxidant properties.

Where oil milling is done by the hydraulic press or the expeller methods the soybean phosphatides remain in the meal and are not easily recovered, whereas with solvent extraction they come out with the oil.

Phosphatides are contained in soybeans to the extent of from 1.6 to 3.0 per cent of the whole bean. Chemically, a phosphatide is a phosphoric acid derivative of a glycerol ester which contains as an organic base either choline or colamine. Where choline is present the phosphatide is called lecithin, and where colamine is a component the name is cephalin. An analysis of commercial soybean phosphatides by Nottbohm and Mayer (3) showed that only 38 per cent of the phosphatide fraction could be classed as lecithin, the remaining 62 per cent containing no choline.

The application of organic solvents for extraction of the phosphatides from soybeans results in the splitting off of at least a part of the carbohydrate group which is present in the phosphatide complex, but it is impossible to free the phosphatide from the remaining carbohydrate by any known solvent (2).

A decade ago a plant was in operation at Imienpo, N. Manchuria, where the oil and the phosphatides were extracted from the soybean by the Tcherdynzev process, ethyl alcohol being used as the solvent. An article published in 1929 by Sato (5) states that 96 per cent alcohol at a temperature of 75 deg. C. is suitable for extraction. When the miscella, the liquor obtained in extracting the soybeans with ethyl alcohol, is cooled to room temperature, the oil and alcohol separate into two layers, the upper being an alcoholic solution of phosphatides and some admixtures. This upper layer, which carries about 6 per cent of the original soybean, contains on an alcohol free basis 27.53 per cent carbohydrates calculated as invert sugar, 1.27 per cent nitrogen, and phosphatides equivalent to 1.07 per cent phosphorus. Coagulation by calcium chloride seems to give the best separation of the phosphatides and carbohydrates from the alcoholic extract.

The alcohol extraction process is remarkable for its simplicity and the non-toxic nature of the solvent, and would be particularly suitable for solvent extraction plants of the rural type. It could also furnish a use for the industrial alcohol derived in the United States from corn, thus creating an outlet for corn and soybeans alike.

The Bollman (1) process of extracting soybean phosphatides depends mainly on the application of a solvent mixture of ethyl alcohol and benzol, which is able to dissolve lecithin as well as oil, free fatty acids, and resinous and bitter matter from vegetable raw materials, but leaves undissolved the carbohydrates soluble in alcohol. The most advantageous results are obtained by using a mixture of 2 parts alcohol and 3 parts benzol. Care must be taken that the raw materials do not contain more than 10 per cent moisture. When too great dilution takes place, the solvent mixture will separate into its constituent parts.

The extract obtained from the process is warmed until the solvent mixture is vaporized. A decomposition of the lecithin need not be feared, as the oil, in which it dissolves, exerts a protective action. With strong heating, the oil turns dark brown and cannot be made bright again.

After evaporation there remains the oil and the free fatty acids in which the lecithin is dissolved. Also present are small quantities of settlings or deposits which contain the bitter extractive matters, resins and other impurities. These are separated from the oily fraction, whereupon steam is passed into the remaining liquid in order to set free the lecithin which is then separated and freed from any oil sticking to it.

In the Rewald (4) method, the extracted soybean phosphatides are first separated mechanically from the body of the entrained oil by centrifuging. The water contained in the residue, which consists of vegetable lecithin with 30 to 40 per cent of oil, is expelled by distillation under vacuum. After this preliminary treatment, the mixture is dissolved in a solvent in which fats and oils, but not lecithin, are soluble at room temperature, e.g. acetone or acetic esters (ethyl acetate). Preferably the operation is carried out under heat, whereupon the solution is allowed to cool and the vegetable lecithin separates out quite well. As far as possible, the sediment, chiefly lecithin, is separated from the liquid and mixed with a suitable refined fluid, solid oil, fat or pure refined hydrogenated oil, e.g. peanut oil, coconut oil, palm oil, cocoa butter, sesame oil, hydrogenated peanut or sesame oil, etc. Refined hydrogenated soybean oil may also be used. After mixing with the oil, the solvent residue still present in the mixture of vegetable phosphatides and oil is expelled by heating under vacuum. It is important that the oil be added before the acetic ester or acetone is completely removed, because otherwise the vegetable lecithin freed from the oil does not mix uniformly after being subjected to the temperature used in distillation.

If the soybean oil mills of our country had extracted in 1934 only one-fourth of the phosphatides contained in the 7,000,000 bushels of crushed beans that were produced, it would have yielded about 3,500,000 lb. of technical grade phosphatides and provided an additional income of nearly $1,500,000.

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Recent Trends and Developments In Chemical Engineering

EDITORIAL STAFF REPORT

Editor's Note: Several volumes will eventually be required to publish all of the important papers and discussion summarized briefly in these pages. Readers desiring copies of any particular papers may order them by letter and number from the Papers Bureau, International Secretary, 36 Kingsway, London—or on request we shall be glad to loan our file copies to those who will return them promptly.

A REVIEW of the outstanding papers presented at the Chemical Engineering Congress in London reveals progressive trends in nearly every branch of the professional field. In the report which follows are presented notable points from papers which treat of subjects ranging all the way from materials of construction to optical aids. It has been attempted to group the papers as nearly as possible according to their subject matter, and consequently there is, in certain places, some deviation from the original sequence of presentation.

In the first paper of the ferrous metals group, Burton, Hatfield and Service (A1) summarize the response of metallurgical research to the present day demands for steel forgings for the handling of fluids at high temperatures and pressures. It is pointed out that alloys containing nickel, chromium, or aluminum seem to offer the best resistance to deterioration under conditions of high stress.

Sarjant and Middleham (A3) emphasize the need for improved materials of construction in the high-pressure synthesis field. The essential requirements for high-pressure autoclave steels, depending upon conditions of operation, include adequate mechanical properties, high resistance to creep, stability under heating, immunity from attack by hydrogen, and, in specific uses, resistance to corrosion and scaling. In a discussion of the influence of operating conditions on hydrogen attack, it is pointed out that the decarbonization which occurs as a result of the diffusion of hydrogen into ordinary steels at comparatively high temperatures, takes place under the effects of pressure at considerably lower temperatures. The highly alloyed austenitic steels (18 per cent Cr, 8 per cent Ni; 18 per cent Cr, 8 per cent Ni, with Mo and Ti; and 25 per cent Cr, 18 per cent Ni) are shown to possess the optimum combination of desirable properties for high-pressure work.

Steels for Pressure Vessels

In a paper on the construction of pressure vessels for the petroleum industry, R. K. Hopkins (G7) of the M. W. Kellogg Co. states that the old riveted, forge- and hammer-welded, and seamless forged vessels are rapidly being replaced by the modern fusion-welded type. For high temperature service, molybdenum steel has been found to be the most satisfactory and not too expensive. For low-temperature service, a possibility is claimed that the expensive 2.25 per cent nickel steel of the type used in locomotive boilers will be replaced by a plain carbon steel which has been deoxidized by a special process. For resisting chemical attack, metal spraying and chromium plating have not been generally successful; refractory linings have been employed but require frequent renewals. A promising development is the use of bi-metal plate, which on one side has a corrosion-resistant material such as a straight chrome or chrome-nickel steel, and on the other the regular carbon steel base metal.

Corrosion Resisting Metals

Hatfield (A2) presents an extensive account of the specific characteristics of several general classes of corrosion resisting and acid resisting alloy steels. A number of industrial operations and processes are listed with specific recommendations as to the most suitable alloy. Warning is made that the applicability of such a list is strictly limited by the purity of the substances involved, since a small percentage of foreign matter may change the corrosive characteristics so that an entirely different alloy should be specified.

Norlin (B9) describes the Swedish chemical industry's experience with non-corrodible materials. Attention is called in the case of ordinary 18-8 steel to the greatly increased resistance to corrosion given by a highly polished surface. Tests on the joining of stainless steel sheets with bolts of the same material showed ready corrosion on the lower side of the bolt head and in the thread when immersed in ordinary tap water for a couple of months. This is explained as being the result of the destruction of the chromium oxide layer on the surface of the steel and may be avoided by applying a thick red lead mixture between the two sheets at the joint.

A paper by Kuhr and Pfeiffer (A7) discusses the mechanism of corrosion of iron pipe lines in damp ground in the absence of atmospheric oxygen (anaerobic corrosion). This type of corrosion may be regarded as an electro-biochemical process and may be most effectively prevented by protective coatings of asphaltic bitumen. The essential requirements for an effective coating on iron pipe are: thickness of at least 0.35 mm.; good adhesion; good resistance to flow, ground pressure,

shock and distortion; and absence of aging and checking.

Use of cast iron in the chemical industry is the subject of papers by H. L. Maxwell of E. I. duPont de Nemours & Co. (A8) and Pearce of Great Britain (A5). A ready response to alloying and heat treatment, along with good machinability and low cost, makes cast iron adaptable to a wide range of plant service conditions. Whereas it may not be properly classed as a corrosion-resistant material as compared with high-alloy steel, cast iron does possess sufficient immunity to make its use economical in many instances where corrosion is a factor. Appreciable improvements may be made with alloy additions. Nickel-chromium additions are usually beneficial, although a small amount of the latter alone is often detrimental to corrosion resistance. Irons containing 13 to 16 per cent silicon have been used for the past 30 years where resistance to acid was required. These alloys show excellent resistance to sulphuric and nitric acid, but are attacked by hydrochloric acid. Their use is limited by their susceptibility to thermal and mechanical shock.

Austenitic cast irons were developed about 12 years ago and have since found wide application in the process industries. There are four of these alloys that should be referred to as representing typical compositions of this class of material. They are regular Ni-Resist, copper-free Ni-Resist, Nicrosilal and Causul. The value of these cast irons lies in their resistance to heat and corrosion. The nickel, chromium, carbon and silicon combine their influence to produce a matrix that is but little affected by oxidation at high temperatures or by acid attack at low temperatures.

A paper by Rohrig (B10) on the use of aluminum as a material of construction in chemical plants provides much information on the fabrication, maintenance and cleaning of that material.

The recrystallization of aluminum is discussed by Trillat (B12). It is stated that refined aluminum recrystallizes at lower temperatures and with much greater speed than does the commercial product. Tests indicate that the breaking strength of the refined metal is less than that of commercial samples.

Technical applications of the use of an oxide film as a protective coating for aluminum are presented by Miyata (D7). Porosity of the film, one of the early difficulties encountered, has been eliminated by a steam treatment. The surface of the porous film exhibits properties of absorption and adherence which make it useful as an underlayer for protective paints. The operation of applying the coating is an anodic process which is carried out in a bath of oxalic acid.

Other Materials of Construction

The chemical inertness of certain of the long list of plastic materials on the market today is appearing to offer a new solution for a number of plant equipment corrosion problems. This particular field of uses for plastics is covered in a British paper by Potter (B4). Instances are cited in which the superior corrosion-resisting properties of plastic coatings on wood or metal have won out over the ever-present cost factor.

Brazier (B5) discusses the use of solid rubber and rubber-lined equipment for chemical plant work. Where rubber is used as a protective lining, the surface condition of the metal to which the rubber is to be applied requires careful consideration. The use of welded seams is much to be preferred, but it is essential that porosity in the welds be avoided. Porosity in castings is an even more common cause of trouble, and it is evidenced by a blistering of the lining. Rubber linings which have greatly increased resistance to oils and high temperatures have recently been developed.

Hickman, Hodson and Speirs (B3) discuss the development of chemical stoneware during the last 30 years, with particular emphasis on improvement in heat conductivity, mechanical strength, and resistance to attack by alkalis. Some practical pointers on the installation and maintenance of stoneware equipment are given.

Lathe (B1) describes some new Canadian refractories which have resulted from the commercial development of extensive magnesium carbonate deposits at Grenville, Que. A refractory exhibiting improved resistance to hydration has been produced by increasing the silica content to 30 per cent and substituting chromium oxide for iron oxide as a stabilizer. A refractory brick of very high spalling resistance has been developed by combining 30 per cent coarse chromite with 70 per cent of fine magnesia-lime refractory and burning to develop a calcium silicate bond.

Unit Processes

Graphical computations for the distillation of binary mixtures are presented by Oman (C12), and of ternery mixtures by Nash and Strang (C8). G. G. Brown, professor of chemical engineering, University of Michigan, (C14) discusses methods of calculating the number of theoretical plates required for the fractionation of multi-component mixtures. He also includes a number of points on column design, plate efficiency, and the effect of entrainment. A description of Podbielniak's new centrifugal fractionation unit is included, along with a comparison, from the standpoint of thermal efficiency and power consumption, with the conventional column design.

The subject of solvent extraction units for the refining of lubricating oils is ably discussed by Hunter and Nash (C18). A comparison is made of the efficiencies of mechanical agitators, concurrent contacting columns, jet contactors, and counter-current columns, with the final conclusion being that in general the contacting equipment using mechanical agitation with continuous counter-current flow is most satisfactory. A method of computing the extraction efficiency of such a machine is given.

Courbis (C20) investigates the mechanism of crystallization of salts from both simple and multiple aqueous solutions. The two chief types of industrial crystallization, (1) by cooling and (2) by evaporation, are described in detail. The paper is concluded with notes on methods of producing crystals in apparatus in which crystallization takes place during agitation.

A comparative account of the numerous and varied types of commercial filter presses is ably presented by Alliott (C9) with detailed information covering applications and operation. The following brief outline of the characteristics of the plate and frame type of pressure filter, one of the ten varieties discussed, will give

some idea of the vast store of useful information contained in this paper. Advantages and disadvantages of frame presses: adaptable to almost every problem, including plain filtration, high-speed clarification, washing or air-drying cake, heating or cooling, etc.; give driest cake; cloths readily changed; suited to both low and very high pressures; low capital cost per unit filter area; simple and foolproof; not suitable for very volatile products; cloths are subjected to pressure at the joint surfaces; cost of discharging becomes important for large scale work, particularly where the filter cycle is short; washing thickness is double the filtering thickness, and channeling often results. Similar accounts are given in a more detailed manner for leaf filters, metafilters, streamline filters, sand filters, pulp filters, "film" sterilizing filters, tank type vacuum filters, and rotary continuous vacuum filters. Information is given also on the installation and operation of each type.

The rate of the air drying of solids, both during the constant rate period and the decreasing rate period, is discussed by T. K. Sherwood, assistant professor of chemical engineering, M.I.T. (C15). It is pointed out that the thermal efficiency of a dryer increases with increasing exhaust air temperature. Antoni (C19) reviews methods and applications of spray drying in industry. Although this type of drying is of comparatively recent origin, it has proved to be one of the most economical methods, from the standpoint of both heat and labor requirements, for drying delicate materials. Its application is rapidly spreading into the fields of powdered foods, cement, refractories, milk, soap, and organic products.

An electrolytic treatment for the prevention of boiler scale in hot water systems is described by Thomsen (D2). The hot service water is subjected to a slight electrolysis, whereby the composition of the water is so modified that it has no tendency to deposit lime nor to corrode the boiler walls. Attention is called to the probability that preceding corrosive attacks form the basis for boiler scale deposits.

Petroleum Refining

An interesting new process for the fractionation of heavy petroleum oils is described by Pilat (C11). The oil is dissolved in a light hydrocarbon and subjected to the introduction of methane under high pressure. This causes a gravity separation of the primary fractions. An outstanding characteristic of the process is the moderate operating temperature (20 deg. C.) which eliminates the risk of thermal decomposition, a frequent source of trouble where separation is made by distillation.

Gustav Egloff and E. E. Nelson (C13) of Universal Oil Products Co. present an extensive summary of modern petroleum cracking technology. The effect of the physical properties of petroleum on distillation equipment design is discussed, along with materials of construction for cracking plants. Attention is called to the economic significance of the cracking process and its position as the dominating factor in the conservation of crude oil.

Improvements in the well-known phenol refining process for lubricating oil are described by Stratford (F1). As a result of recent investigations, the recovery of phenol from phenolic water has been made both much simpler and more efficient, emulsification difficulties have been eliminated, corrosion of equipment has been reduced, and large cumbersome treating equipment has been replaced with flexible centrifuges or simple countercurrent towers. The author further discusses the question of dewaxing before or after phenol treating, the production of two treated distillates simultaneously in one operation, improvements in yield and viscosity index of lubricating oils by the addition of water to the extract and by increasing the temperature of treating, and the use of a mixture of cresol and phenol.

The use of liquid propane as a solvent for the removal of asphalt, paraffin wax, heavy ends, the so-called naphthenic constituents, and colored matter in the refining of heavy oils is discussed by Wilson, vice chairman, Pan American Petroleum and Transportation Co., Keith of the M. W. Kellogg Co., and Haylett, director of manufacturing, Union Oil Co. of California (F8). In addition to having the remarkable property of tending to throw out of solution all five of these undesirable constituents, liquid propane is extremely cheap, non-toxic, non-corrosive, and highly stable. Of commercial importance is the fact that propane refining makes readily available a whole series of high melting point waxes and petrolatum of extremely high quality, and new types of asphalt having unusually desirable emulsification properties.

Gas Industry Developments

In view of the growing importance of the technological processes of synthesis and hydrogenation, considerable interest is attached to Karzhavin's paper (C17) on industrial methods for obtaining cheap hydrogen from methane-containing gases. Both the intermittent and continuous processes involving conversion with steam in the presence of a nickel catalyst are discussed. The intermittent process consists of alternately passing gas-steam and gas-air mixtures through a refractory packing in the presence of the catalyst. The process can be realized on an industrial scale without any difficulty. In the continuous process, a mixture of gas and steam with a suitable amount of oxygen is heated to 350-400 deg. C. and passed over the catalyst in the conversion tower. The heat of the converted gas from the contact apparatus is used to heat the entering gas-steam mixture. The expediency of using the continuous method depends upon the availability of cheap oxygen and upon the cost of gas. These modern industrial methods of conversion produce a gas containing from 0.5 to 0.8 per cent methane.

A. C. Fieldner, chief engineer, Experiment Station Division, U. S. Bureau of Mines, and J. D. Davis, senior fuel chemist, U. S. Bureau of Mines (E13) describe the method used by the American Gas Association for testing the carbonization properties of coal. Graphical results of yield of coke, tar, light oil, gas and ammonium sulphate for several different coals at different carbonizing temperatures are given. The practice of blending coals for carbonization is investigated and results are presented from a series of tests wherein varying quantities of a high-volatile Pittsburgh bed coal is blended with low-volatile Pocahontas coal. The following conclusions were drawn from these tests: actual yield of coke and gas from the blend did not vary, but the proportion of hydrocarbon decreased and the hydro-

gen increased as the volatile matter decreased; the addition of low-volatile coal lowered the heating value of the gas and up to 40 per cent it produced decided improvements in the physical quality of the coke.

In Russia, the process of underground gasification of coals is finding an industrial application in supplying gas for boiler furnaces, gas turbines and chemical synthesis. First suggested in 1888 by Mendelejeff, the idea of reducing unworkable coal deposits to a gaseous state, with the attendant saving in mining expense, has not received much commercial consideration until the advent of two new processes which are described in a paper by Chekin, Semenoff and Galinker (E12). Both methods provide for gasification of the coal in its virgin state, the early practice of breaking up the beds with dynamite being eliminated entirely. The Gorlovka method uses narrow shafts sunk in the coal bed and connected by cross tunnels either through the bed or along its lower limits. Combustion along the tunnel walls is supported by oxygen enriched air blown periodically through a shaft at one end, the gas being drawn from a similar shaft at the opposite end. This underground producer combines the three industrial processes of coal production, coal gasification and carbon monoxide conversion. In the regenerative method, the air flow is replaced by an alternating oxygen and steam flow. The aim here is to produce water gas underground, which, because of its low specific gravity, can be transported easily over long distances and can be used for chemical synthesis as well as fuel. Although underground gasification still awaits the assistance of the chemical engineer in solving problems of heat exchange, heat loss calculation, measurement of temperatures, and the dynamics of the gasification process along the tunnel ways, its possibilities do provide new hope for gas consuming processes which formerly have been regarded as uneconomical.

In Japan, it is hoped that the low temperature carbonization of coal will develop as a means of producing liquid fuel, owing to the scarcity of natural petroleum in that country. The industry has not, however, made rapid progress until recently because of the difficulty of disposing of the semi-coke. Ban (E10) describes a plant which has been adapted to the carbonizing of dust coal, the semi-coke produced being blended with the bulk of coking coal for the purpose of manufacturing metallurgical coke of good quality. Muller (E7) states that in nearly all cases of failure of the low temperature process, the difficulty may be traced to faulty heating and equipment construction, combined with a lack of knowledge of the mechanism of carbonization. The requirements for successful operation are: carbonization at rest and in thin layers, and the attainment of maximum heat economy through the use of a system which allows maximum heat transfer at the low working temperature used in the process.

Purification of City Gas

The removal of carbon monoxide from city gas by means of single-stage catalytic conversion with steam to carbon dioxide and hydrogen is treated in a paper by Mezger (C5). Attention is called to the need for improvement in chemical engineering design which would effect increased heat and power efficiency.

The removal of hydrogen sulphide from coke oven gas is described by Pieters (C10). The gas is scrubbed with a slightly alkaline solution, preferably ammoniacal, which contains an oxygen carrier (complex iron cyanides) to oxidize the hydrogen sulphide to sulphur. Regeneration is carried out by aerating the solution.

The recovery of benzol from city gas is treated in papers by Adam and Anderson (C7) and Plenz (C3). The two processes which are in current use are based either on the absorption of benzol by liquids (oil) or on its adsorption by solids (activated carbon). The former process consists of providing conditions of counter-current flow between the washing medium and gas by means of a bubble plate column, tower scrubber or mechanical washer. In the activated carbon process, use is made of the selective absorption properties of charcoal. This process has been made successful by the marketing of a high quality activated carbon which is free from troublesome secondary reactions. It shows some advantage over the oil washing process in its lower steam consumption, freedom of the benzol from wash oil, and higher extraction efficiency both for benzol and organic sulphur compounds contained in the gas. During recent years much has been done to improve the oil washing process. High steam costs and poor separation of the benzol from the wash oil, the two major defects of the process, have been overcome by the extensive use of heat exchangers and through separation by fractional condensation and distillation. While the oil washing process has the advantage that it can be used on gas containing hydrogen sulphide, and is therefore suitable for use in coking plants, the activated carbon process introduces refinements in the final purification of the gas going to the mains.

Disposal of Industrial Effluents

Because of the gradually increasing localization of chemical industries in city areas, the disposal of industrial wastes is becoming a consideration of great importance. Three authors have devoted the contents of their papers to this problem. Calvert (F3) and Stevenson, chief engineer, Pennsylvania Department of Health, (F7) both advocate a careful study of manufacturing processes in order to avoid the production of industrial effluents, to recover valuable byproducts, or to reduce in quantity and polluting quality any effluent necessarily produced. The need for research is emphasized in finding new byproducts of marketable value which may be added to the few now recovered from industrial wastes. Appended to Stevenson's paper is a number of known processes for the treatment of certain industrial wastes. In a discussion of the subject of disposal of gaseous effluents, Damon and Wylam (F4) survey methods of treatment whereby the noxious constituents may either be recovered in a useful form or destroyed, so as to render the emission inoffensive.

A paper by Oshima (*G*5) presents an interesting account of the combined synthetic ammonia and methanol plant of the Synthetic Industries Co. of Japan. In the methanol section of the plant, water gas is first made, and part of the carbon monoxide so produced is used in the conversion of steam into hydrogen to provide a suitable ratio of carbon monoxide to hydrogen. This gas is passed into the first catalytic chamber working under 300 atm. pressure and methanol is formed which

is separated by cooling, the remaining unreacted gas being recirculated. As the initial water gas contains 7 to 8 per cent of nitrogen, which tends to accumulate in the circulation gas, a part of it has to be purged in order to maintain favorable working conditions. Keeping the nitrogen content in the purged gas at 20 to 25 per cent, it is mixed with the blow gas of the water gas operation, and the greater part of the carbon monoxide in the resultant gas is converted into hydrogen. The converted gas mixture is then passed into the second methanol chamber working under 1,000 atm., where the remaining carbon monoxide is converted into methanol. The excess gas from the chamber, consisting of a suitable mixture of nitrogen and hydrogen, is passed into the ammonia section, which operates under the Claude system. The combined plant can produce 1,500 tons of methanol and 1,000 tons of ammonia per year.

Heat Economy and Heat Transfer

The much studied subject of heat economy in evaporation processes has been brought to the fore again in a Swedish paper (H5) which describes a promising new method of evaporator operation at low temperatures using waste heat. The waste heat, either in the form of flue gases or hot reaction vapors, preheats the liquid to be evaporated as well as a permanent gas (air) which is used as a heat carrier in the system. The liquid from the pre-heater goes to the direct evaporator where it flows in a thin layer over a perforated plate, the permanent gas being forced by means of a fan up through the holes in the plate and at the same time across the flowing layer of liquid. It was found that the dimensions of the holes and their location are of capital importance in the prevention of foaming. Since the coefficient of heat conduction is very high in direct heat exchange, plate surfaces of moderate dimensions are sufficient. The process is divided into the two phases of heating and evaporating, which results in the change in concentration taking place at the free surface of the liquid and not on the heating wall, contrary to the usual evaporator. In this way, incrustation, which is one of the chief problems in the steam evaporation of sulphite liquor, is avoided. As in ordinary evaporation, maximum heat economy is obtained by multiple-effect operation. It is possible that this new method will provide a satisfactory solution to the difficult problem of the evaporation of sulphite liquor.

An accumulator for the recovery and storage of heat from the intermittent blow-down of digesters in the sulphate pulp industry is described by Rosenblad (H6). Use is made of a heat exchanger having spiral passages of sheet-metal construction. Since it is desirable that the exchange of heat be as nearly complete as possible with only a single passage of the liquid through the exchanger, it follows that the quantity of liquid flowing through must be extremely small in relation to the size of the exchanger. In fulfilling this requirement, the spiral design eliminates the repeated turns, frictional surfaces and non-heat-transferring breaks which are characteristic of the multiple-pass and series types of heat exchangers. The thin sheet-metal walls of the spiral passages and the high liquid velocity are the basis for claims of very high heat transfer coefficients obtainable in the new apparatus.

The application of induction heating in the process industries is relatively recent. C. E. Daniels, engineering department, E. I. duPont de Nemours & Co. (H8) states that in general the temperature requirements of the chemical industry have been low, but the trend is upward and is leading toward electrical heating. Below approximately 350 deg. C. the use of resistance heating elements in various forms is usually economical and satisfactory. In the range between 350 deg. C. and 600 deg. C., the use of induction heating becomes attractive or even necessary in cases where difficulty is encountered in establishing satisfactory contacts or in concentrating the desired heating input in the available space.

T. B. Drew, chemical engineer, duPont Experimental Station; H. C. Hottel, associate professor of fuel engineering, M. I. T.; and W. H. McAdams, professor of chemical engineering, M. I. T. (H7) present a progress report on research in the field of heat transfer. It is principally of a practical nature, and should be of great use to the designer.

It is gratifying to note that the chemical engineering profession is perceptive enough of the importance of its manpower supply to devote an entire section (J) to technical education. Austria, Germany, Great Britain, Japan and the United States contribute papers on development in methods of training the chemical engineer in the respective countries. There seems to be general agreement on the importance of developing in the individual the ability to apply common sense and clear thinking to engineering problems. Without these faculties of effective application, the greatest store of technical facts is of little value.

In a running account of advances in chemical engineering in Canada, Whitby and Green (M3) devote considerable space to the pulp and paper industry which, it is stated, is the largest employer of chemical engineers in Canada. A ten-effect horizontal evaporator for "black liquor" is described which embodies several novel features. The liquor is inside the tubes and is held there by troughs attached to the tube sheet at each end. The feed is distributed into the inlet tubes by spray nozzles, so that the boiling liquor is never more than 1 in. deep and heat loss due to static head is avoided. The very large disengaging surface in each effect makes the evaporator suitable for foaming liquors.

Optical Aids in Chemical Work

An excellent paper by Lowe (M7) reviews the various kinds of optical apparatus which are at the service of the chemical manufacturer and engineer for building a faster and more accurate system of product inspection and control. Apart from a check on the finished product, chemical engineers are enlisting optical aid in the supervision of operations in which it is essential quickly to recognize and abate nascent errors. The paper describes the application of microscopy, photo-micrography, fluorescence, colorimetry, color measurement, nephelometry, polarimetry, refractometry and interometry to 19 groups of chemical products. The practical value of the spectroscope in chemical analysis is discussed by Gerlach (M6). In nearly all cases qualitative spectral analysis surpasses in absolute sensitivity the chemical methods. Quantitative spectral analysis in the range from 10 per cent to below 0.01 per cent surpasses chemical analysis in accuracy.

Black Magic

Curling on hypo. In Hollywood's sunshine, the consulting chemist attends this dress rehearsal of a winter carnival

In "Dracula's Daughter," cobwebs (of rubber dusted with fuller's earth), greatly exaggerated to enhance the mood of mystery, confront Otto Kruger as he arrives at the ruined castle in search of his kidnapped ladylove

"TWO hundred lunatics are to fall with a collapsing asylum staircase tomorrow morning at 11. What can we mix with the glue of the joinery to cause it to lose adhesion at the right instant? And how can we sound-deaden a ¼-mile of cobblestone pavement?" In the same breath, some harassed technical director of Paramount, M.G.M., Universal, or 20th Century-Fox, may telephone a consulting chemist and desire to be told immediately how many tons of which chemicals he should buy and dump into a 2,000,000 gal. reservoir in order to galvanize a school of somnolent crocodiles that is even now refusing to emote and are thus holding up an expensive cast.

Upon the correct and prompt answer to such questions that are incessantly being put up to the chemists who act as advisers to Hollywood's directors, hinge profit, loss, artistry, in America's fifth largest industry, "the talkies." With studio overhead metering along at about $2,500 per hour, and an entire producing company stymied by a swarm of bees—attracted to the "plate-glass" store front (fabricated in sugar candy) through which a fire engine is waiting to crash—the bees obscuring the action—time spent on the solution of such typical difficulties is apt to run into important money on the client's books.

One climatic scene in "Ceiling Zero" called for an airplane to crash, buckling in full flight from the weight of accumulated ice on the wings. Congealing, as the horrified pilot (and audience) watched, to the thickness of three inches, the phenomena had to be accompanied by that visible spindrift or scudding sleet peculiar to aeronautic conditions of the stratosphere, a dual problem. Sodium silicate was the answer, in part. The syrup was sprayed from offstage, in synchrony with another gun emitting plaster of paris, the two jets converged at the plane's forward wing edge—and lo, another thrilling illusion was complete.

More in the nature of child's play was another film episode in which a popular child star was alighting at a replica of Grand Central Terminal. Smoke and dust abounded. After viewing the "set," the youngster's doctor forbade her to act in the vitiated air. The chemist was called upon to mitigate the unpleasant atmospheric effects. He prescribed dry ice controlled by a series of blowers of varying horsepowers, as used in present-day "fog sequences."

Solid carbon dioxide, you see, has supplanted the medicinal mineral oil formerly vaporized for this purpose. Actors working for long stretches in the old synthetic fogs were obliged to make frequent costume changes, due to the oil reaching its saturation point in the confines

in the Movies

By A. B. LAING
Hollywood, Calif.

of the set. Now, by passing live steam over the solid carbon dioxide and exhausting the vapor through 6-in. outlets, either a wispy mist or impenetrable "soup" can be readily induced.

As for skating "ice"—the improved surface recently discovered is doubtless responsible for a whole cycle of rink-localed pictures emanating from the film capital. Among the first to cavort on this new chemical surface were the Goldwyn girls, a chorus appearing in "Kid Millions." They were soon followed by a host of others.

All Hollywood rinks were once constructed of plain photographic hypo. But this had certain limitations, and the resourceful chemical folk at length devised a practical one that was both more slippery and longer lasting. By compounding other sodium salts with the hypo, and mopping down before each rehearsal or 'take,' a more realistic image recorded on the film. The compound is so calculated that the surface is composed of materials having a high proportion of water of crystallization so that when a skater glides across it, the pressure causes a melting water layer under the skate blade.

The structure of the subsurfaces of the improved rinks, sodium ice compound, are microcrystalline in structure. Except for temperature, the material is indistinguishable, in crackle and appearance, from natural ice, that is, in black-and-white photography.

Eighteen tons of hypo crystals were used in the rink built on the M-G-M lot for the amusing film play "Wife vs. Secretary." This modern ice palace, designed by Cedric Gibbons, is equipped with cocktail lounge, rest rooms, orchestra shell, promenades, check-rooms, and balconies for the spectators. After the picture was shot, M-G-M executives decided to leave the three-inch chemical surface intact for recreational purposes and the "stage" has become pleasure headquarters for the firm's employees for night-time skating and hockey games.

Jean Harlow and Myrna Loy decked out in warm toques and mittens on the chemical rink for the filming of "Wife vs. Secretary"

Arctic scenes for the newly improved Technicolor pictures are also interesting. Now that so many of the better movies are being made in their natural hues, all glacial sets and "props" have to be given that slight bluish tinge which is apparent to the human eye. For the tinting of their sodium ice compound, every available dye was tried and the perfect pigment was located only a day or two before actual shooting was scheduled on one big scene.

Only once has the chemist been stumped. An actor was portraying a human skeleton. The director proposed that he be garbed in black with the bone structure limed on the costume in luminous paint. A material for this work of art was sought, one that would photograph by virtue of its own luminosity. With the regular "set" lighting extinguished, the luminous skeleton was to be photographed in darkness so that the wearer's own anatomy would remain invisible. Formulas of several luminous compounds were submitted to studio technicians for trial. None was found to be sufficiently bright for even the supersensitive film and sharper lens now employed in cinema photography.

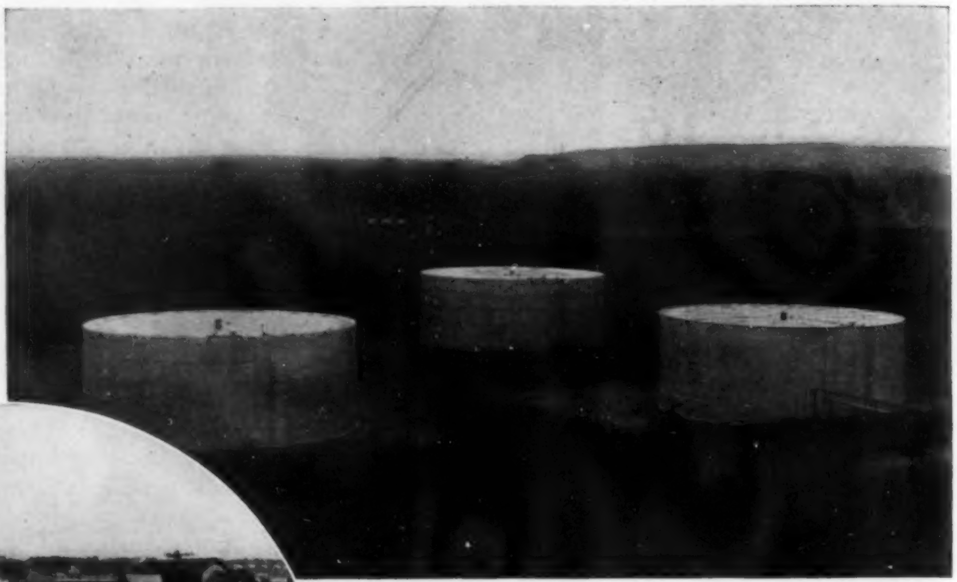
Quiescent volcanoes have erupted at the chemist's behest—spewing powdered aluminum in a thermit mixture; running rapidly, it must be photographed in slow motion. "Cold" fire is another technical accomplishment. It is used when players are cast for conflagration scenes. Delivered to the movie lots in cans, it is composed of a nicely balanced compound of flammable and non-flammable substances. The burning ingredient furnishes the flames—and very realistic ones, too—while the non-flammable ingredient acts to keep the flames cool—otherwise some screen star might lose his pants! But this article has probably gone far enough. As one movie czar who checked the cinematic facts said, "any more revelations might crack all the audience reactions of even the more unsophisticated readers."

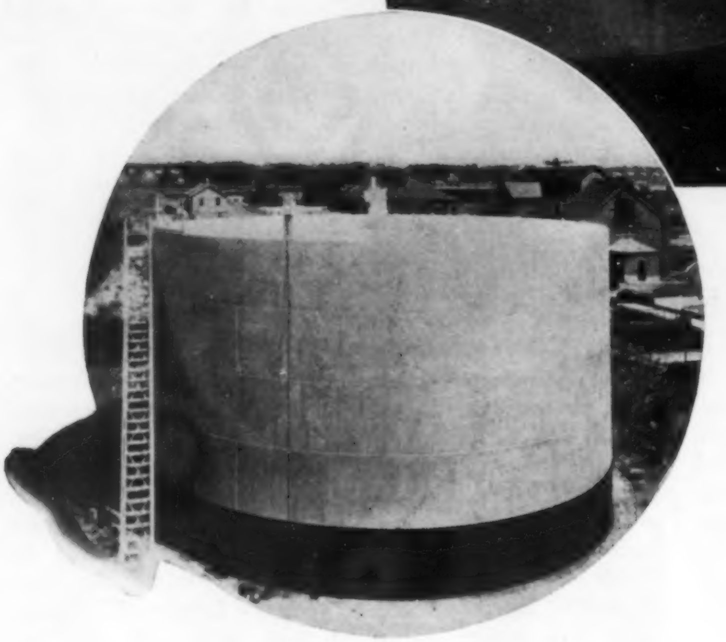
Chemistry has solved many difficult problems of the moving picture director and offers him an important tool with which to solve countless more. The rabbits which the learned professor fetches out of his hat are exhibited to 7,500,000 people each day. From Nome to Istamboul, from smart metropolitan and semi-civilized tribesmen alike, they evoke tears of sorrow or joy, and thrills or laughs. For this reason, you may be willing to concede that this application of the science, if somewhat goofy, nevertheless makes a worthwhile contribution to the happiness of mankind.

The writer wishes to thank Prof. Arthur R. Maas, Dr. Fred C. Bowman and Dr. S. W. Green of the Maas Chemical Laboratories, Los Angeles, Calif., for their assistance in the preparation of this article.

Right—1,000,000-gal. alcohol storage tanks equipped with Wiggins breather roofs

Below—10,000 bbl. gasoline tank with breather roof built by Chicago Bridge & Iron Works for Hartol Terminal Corp., Providence, R. I.

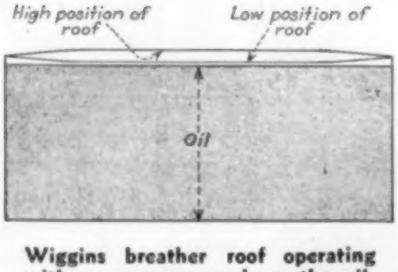




Vapor Control for

By R. S. McBRIDE

Editorial Representative, Chem. & Met.
Washington, D. C.



Wiggins breather roof operating with a vapor space above the oil. On an 80,000-bbl. tank roof flexes about 24 in. at the center

VAPORS of volatile solvents and other chemicals often cause operating and storage difficulties unless special control facilities are used to prevent the escape to the air or abrupt change of pressure of the vapor within the closed units. Not uncommonly, it is necessary to have a small gasometer connected to the vapor space of the storage or operating unit in order to prevent such difficulties. Two more recent devices are now available which appear to have significant advantage for a number of plant conditions.

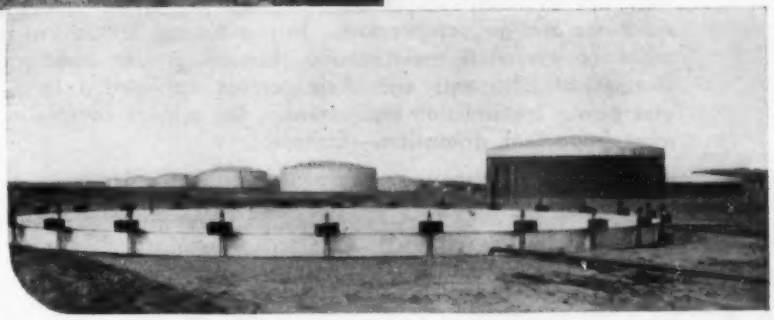
The simplest form of the gas-tight vapor-control system is the breather roof. That variation of tank structure merely provides a flexible top on the storage or reaction tank which will permit flexure with change in temperature or quantity of vapor present. The second new device is a steel "balloon" of variable volume, which permits retention of increasing quantities of vapor or return of collected vapor to a storage or operating unit automatically. The steel balloon is used in what has been called the "vapor-balancing system."

The principles underlying the use of these two plans for vapor control are so simple as to be almost rudimentary. The top of the tank or the two heads of the balloon are welded assemblies of steel plate sufficiently thin to be flexible, permitting change in position relative to the rigid rim of the tank or the outer wall of the balloon. With very slight changes of internal pressures these flexible plates rise or fall, providing more or less vapor space as required. Among the operating hazards thus eliminated are principally:

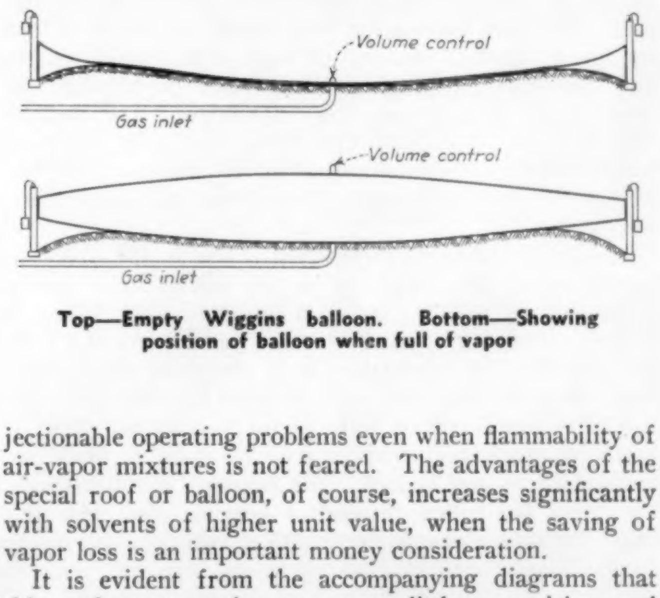
1. Loss of vapor, largely a matter of cost.
2. Formation of flammable, corrosive, or toxic mixtures of vapor with the air outside the tankage during the exhalation.
3. Formation of explosive mixtures of vapor and air by inspiration during low-pressure periods within the vapor space.

Left—This empty balloon is connected to two 55,000 bbl. and two 80,000 bbl. tanks storing natural gasoline at Warren Petroleum Co., Houston, Tex.

Below—The balloon system is at the Continental Oil Co., Glenrock, Wyo.



Safety and Economy



Top—Empty Wiggins balloon. Bottom—Showing position of balloon when full of vapor

4. Irregular operation of multiple tank storage which, if unregulated, may cause difficulties, either because of inadequate interconnection or inadequate vapor space, especially a problem during simultaneous operation to fill one tank and empty another.

All sizes of breather roof and steel balloon units can be utilized. The petroleum industry has built some of the largest. One of the most recent is that pictured, a 250,000-cubic-foot installation, 176-feet in diameter, made for the Warren Petroleum Company at Houston, Texas.

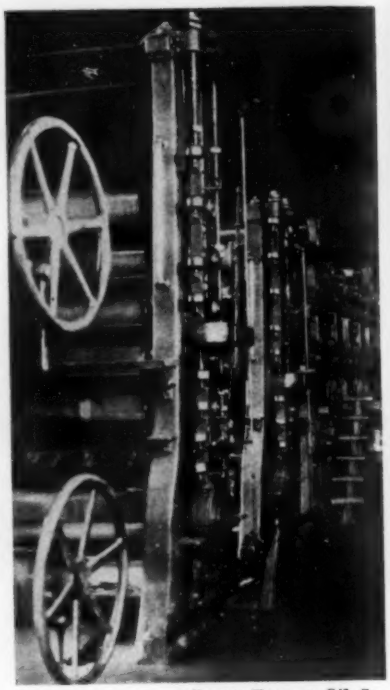
One of the most advantageous features of the vapor balloon becomes evident when this device is employed with outdoor storage tanks exposed to atmospheric temperatures varying widely between day and night. When such tankage is exposed to the sun, the increased quantity of vapor produced might be vented to the atmosphere; but if so, it would not only be lost but also it would occasion any of the objectionable conditions that attend vapor-air mixtures such as explosion, corrosion, or toxicity, according to the nature of the vapor involved. During the cooling down of such outdoor storage tanks, there is always danger that air may be sucked into the vapor space producing flammable mixtures, or other objectionable operating problems even when flammability of air-vapor mixtures is not feared. The advantages of the special roof or balloon, of course, increases significantly with solvents of higher unit value, when the saving of vapor loss is an important money consideration.

It is evident from the accompanying diagrams that this equipment requires no power, little supervision, and no operating expenditure except that incident to painting and structural maintenance. There are no moving parts to get out of order except the valves and the diaphragm of the balloon or roof itself. The construction should, of course, in each case be arranged in accordance with the pressure and other operating conditions anticipated. If corrosive vapors are expected, the balloon must be made of the same corrosion-resistant material as is used for the liquid tankage.

By LAWRENCE G. BENTON and WILLIAM STANIAR
Respectively, Lubrication Engineer and Mechanical Power Engineer E. I. duPont de Nemours & Co., Inc., Wilmington, Del.

LUBRICATION That Makes for Low Cost Operation

In our June issue the authors concerned themselves with the general subject of lubrication in chemical plants, and particularly with the requirements in oils for turbines, steam engines, ice machines and air compressors. In this second article the attainment of minimum maintenance through proper handling and storage of lubricants and their correct application to process and power transmission equipment is the subject completing this most important discussion.—Editor.



Socony-Vacuum Oil Co.

Fig. 1—Wick feed oilers applied to a paper machine calender

MAINTAINING process equipment is one of the most difficult operating problems faced by the works engineer. Aside from deterioration through corrosion, it seems obvious that faulty design of moving parts and poor lubrication are among the most, if not the most, fruitful sources of high maintenance costs; and conversely, that good design and proper lubrication can be made to pay high dividends. The Deacon who built the Wonderful One-Hoss Shay may not have taken potential obsolescence sufficiently into account, but his idea of design was unassailable from the maintenance standpoint.

Design of the parts themselves is not in the province of this paper, but design for proper lubrication is surely a corollary of this discussion of lubricant use. When it is considered that friction between metal parts can only be controlled by lubrication, it is surprising to observe how often the designer fails to provide adequately for this vital item. Often little or no thought is given to lubricant application, leaving it to the user to work out application as best he can. For example, a countersunk hole may be drilled through a bearing cap, with the intention that about 1 c.c. of oil should be used in it, when a quarter that amount would suffice. (Oil of 200 sec. S.U.V. will run about 25 drops per 1 c.c.). Or a sight feed oil cup or a compression type grease cup may be provided, thus putting it up to an operator or oiler to keep the machine running. A neglected bearing means damage or even failure. Hence, definitely controlled lubrication is the answer, and the problem, to insure such control.

The first requisite in industrial lubrication is to avoid contamination of the lubricants, for there seems to be a definite tendency toward carelessness in their storage, handling and distribution. Certain definite qualifications, especially relating to freedom from foreign matter, should be insisted upon.

Lubricants in well packaged containers are delivered to the "Oil House." In many instances this is a shed with a sand or cinder flooring which provides a good starting point for contamination, and also a means for carelessly spilled oil to go undetected. Storage for any industrial concern using a considerable volume of lubricants requires a central oil house, or a special room set apart for the purpose. In all cases radiation should be provided.

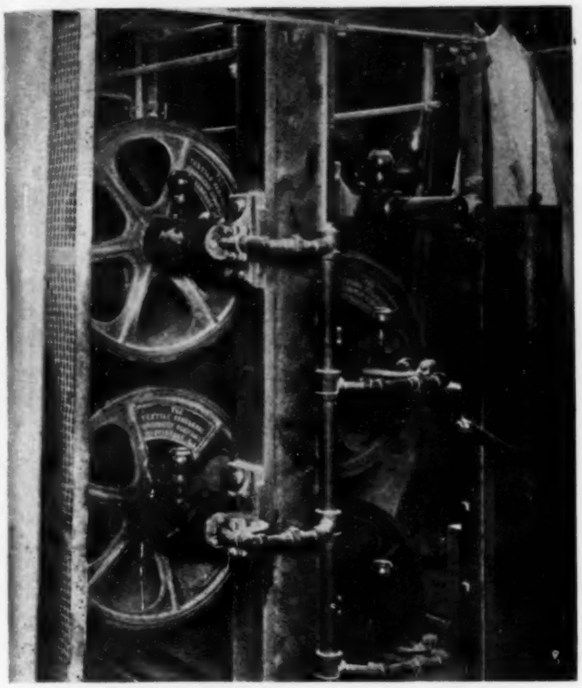
Tanks and Containers—A differential of 3 to 4 c. per gallon under drum price justifies the expense of storage tanks wherever the consumption of lubricating oils warrants purchasing in tank cars. These cars are of 6,000, 8,000 and 10,000 gal. capacity. Two- and three-compartments tank cars are also available, having a combined capacity of from 6,000 to 8,000 gal.

With this type of car, two or three different oils may be received in one shipment.

Where the installation of bulk storage is not warranted, steel tanks of from 60 to 300 gal. capacity should be used. These tanks should be equipped with self-measuring pumps and counters so that records can be kept and charges apportioned to the several departments. Distribution of lubricants from the oil house should be studied from a labor cost standpoint. Often it will be found economical to install 60- or 120-gal. pump tanks at various points, rather than to issue requisitions for small lots at frequent intervals.

Greases are shipped in metal containers of 1, 3, 5, 10, 25, 50, 100, 200 and 400 lb. capacity. The package size most adaptable to the requirements of the particular plant should be determined.

Smaller sizes are higher in price than the standard



Socony-Vacuum Oil Co.

Fig. 2—Bottle oilers employed on cooling roll bearings of a calender for rubberized fabrics

400-lb. package, but may prove more economical when handling costs are considered.

Extreme care is necessary with greases in preventing contamination. Packages should never be left uncovered for the entrance of abrasive material, for even a small quantity combined with the grease and used for the lubrication of anti-friction bearings will necessitate not only an expensive replacement, but the shutting down of the process as well.

Plant management must bear in mind the extreme importance of cleanliness in the handling of lubricants. Accessories such as funnels, measuring cans and all containers should be covered when not in use. Any dirt present in such equipment will eventually lead to contamination, which means excessive wear on the bearings and their ultimate failure.

Oilers—The belief is common that the employment of an oiler is not necessary. It is generally argued that the machine operators can attend to lubrication, but experience has proved that the service of an oiler is a good investment, provided the right type of man is selected and trained. Customary practice is to employ a boy for this work, with instructions to keep oil and grease cups filled, but the results are seldom satisfactory. The better plan is to train a man who possesses mechanical experience. Such a man will follow instructions willingly for he will appreciate the fact that bearing failures are his responsibility. Moreover he will often observe weaknesses in plant equipment and report the matter before failure occurs. It is surprising to observe how efficient a man in this work will become when properly instructed and encouraged.

The proper function of the oiler, however, should not be simply the filling of oil and grease cups. Among many industrial concerns throughout the country the number of bearings, both large and small, runs into the hundreds of thousands. A large percentage of these are of the plain bushed or babbitted type. The amount of money that can be spent in an attempt to hand lubricate these bearings is astonishing. When the direct labor cost is coupled with the cost of maintenance and loss of production on account of bearing failures and the cost of wasted oil and goods damaged by oil spotting, resulting from over-lubricated bearings, the need for satisfactory methods of mechanical application of lubricants becomes evident.

Mechanical Lubricators

Although high in first cost, the installation of mechanical lubricating equipment is generally a paying investment, since hand application often costs from 50c. to $2 for each dollar's worth of oil purchased. In addition, there is the accident phase of hand application. Compelling men to climb ladders to reach the points to be lubricated is a hazard that can be overcome by the use of proper lubricating devices.

It is only within the past few years that serious study has been given to the subject of lubrication. Formerly it was considered merely as a necessary evil. Today, however, equipment for the controlled application of lubricants may be secured from several reliable manufacturers. An idea of the methods employed may be gained from a study of two or three types of lubricator, and their applications.

Autoclaves—The bearings and packing of chemical plant autoclaves are difficult to lubricate. In many instances operating temperatures are high, the materials handled are destructive to lubrication, and sometimes lubricating oil must not be allowed to leak past the bottom guide bearing.

A successful lubrication method shown in Fig. 3 can

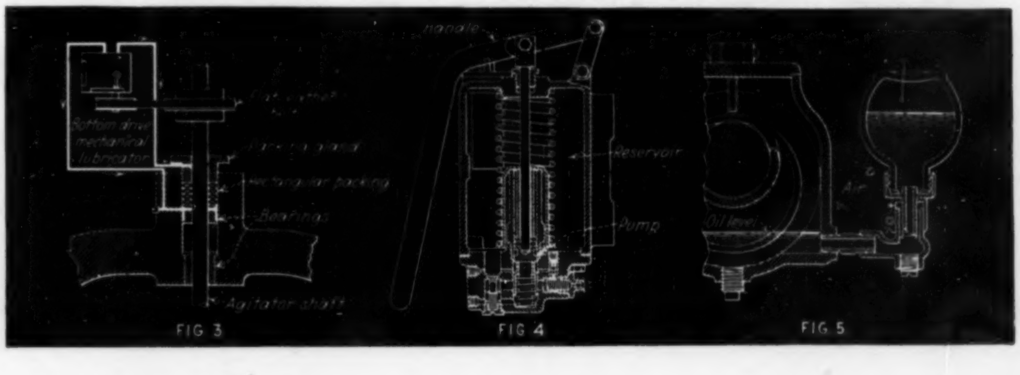


Fig. 3—Bottom drive lubricator oiling autoclave bearings

Fig. 4—Farval oil compressor for "one-shot" lubrication of multiple-bearing machinery

Fig. 5—Alvor constant level oiler applied to a ring-oiled bearing box

be provided by installing force feed lubricators, with bottom rotary drives. If convenient, the shaft coupling can be used as the driving pulley and the lubricator driven by a 1-in. belt. The driven pulley should be flanged.

Two oil leads, made of $\frac{5}{16}$-in. copper tubing, are generally used. One is connected to the stuffing box gland, which is drilled and tapped for a $\frac{5}{16}$-in. compression type fitting with a union connection. The second lead is connected to a drilled hole in the cast iron bearing support so as to apply oil to the top bushing. Leakage lubricates the lower bushing.

Oil For Autoclaves

An autoclave having a shaft of $2\frac{15}{16}$-in. diameter, running at 35 r.p.m., will require about one drop of oil in 10 minutes to the packing and one drop in 6 minutes to the bearings. If the operating temperature is above 60 deg. C., use a steam cylinder oil as a lubricant. If below 60 deg. C., use a heavy engine oil of about 500 seconds viscosity. With this type of lubricator, no attention is required on the part of the operator, except occasional filling. As the lubricator is driven from the machine it starts and stops with the operation. This results in the elimination of both flooding and starving of the bearing.

Bottom drive lubricators are furnished in ratios from 50 to 1,600 to 1 (i.e., revolutions of the lubricator pulley to one stroke of the pump). The pump may be adjusted to deliver from 1 drop to 13 drops per stroke. This type of lubricator is also furnished for horizontal rotary drive and oscillating motion. It has been found adaptable to a number of operations, including rubber mill and rotary mill bearings which are difficult for the oiler to serve and therefore are often neglected.

Multiple-Bearing Equipment—Although it is not as generally applicable in chemical plants as in textile and flour mills, the "one-shot" type of mechanical lubricator is useful for a considerable number of process applications, in cases of medium- and high-speed service.

How "One-Shot" System Works

The oil compressor used in one system is shown in Fig. 4. It consists of a central reservoir containing a spring loaded pump of about 20 c.c. displacement. Lifting the handle fills the pump barrel and on release the spring operates the pump ram, discharging the oil to the system. A $\frac{5}{16}$-in. copper tube conveys the oil to all parts of the machine. At a point opposite each bearing the line is tapped and a metering valve inserted. From this valve a copper tube delivers oil to the bearing or part to be lubricated. With this arrangement the quantity of oil discharged is controlled by the construction of the metering valve, which is available in seven different sizes, varying in capacity from $\frac{1}{4}$ drop to 11.7 drops, and is not adjustable. One "shot" of the pump will deliver oil to from 50 to 75 points, requiring but 30 seconds for the operation. Pumps driven from the machine may be installed if frequent application is required. They may be timed for any frequency of operation. For heavy duty continuous service, as in steel mills, devices in the shape of direct acting pumps with metering valves designed for grease application are available.

Shafting and Motors—Still another automatic lubricator is the constant level oiler, one type of which is shown in Fig. 5. Shafting supported on ring oiling bearings is generally oiled once per week. However, when such bearings are equipped with constant level oilers, attention is required only at two to four month periods, depending upon the capacity of the oiler. Oilers of this sort are also extensively used on electric motors of the ring oiling type. The value of this device lies in the fact that it is not necessary for a man to inspect the oil level daily. If oil shows in the bottle, the oil level in the bearing must be correct. With the oil level held constant, seepage and over lubrication are under control. Such oilers are obtainable with glass or non-breakable bottles. They are built in sizes from $\frac{3}{8}$ to 16 fl. oz. capacity.

Lubrication of Ball and Roller Bearings

Correct lubrication of ball and roller bearings depends upon the consistency, quality and quantity of the lubricant. There is also a definite relationship to bearing design, the type of machine and the conditions of operation. The lubricant must not only function as such, but must also protect the highly finished surfaces from rusting and corrosion. Bearing surfaces are very susceptible to corrosive action when in the presence of moisture or free acid. Water may gain entrance to the housing, or condensation (sweating) may occur. A lubricant exposed to high temperature and moisture may oxidize and produce an acid condition. If iron oxide forms in the housing and becomes incorporated in the lubricant, its abrasive action will soon ruin the bearing.

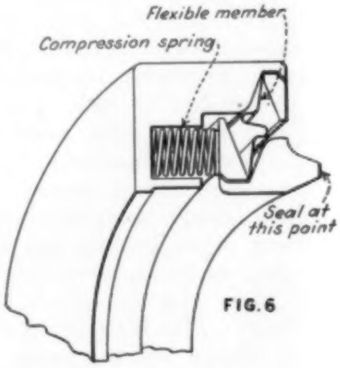
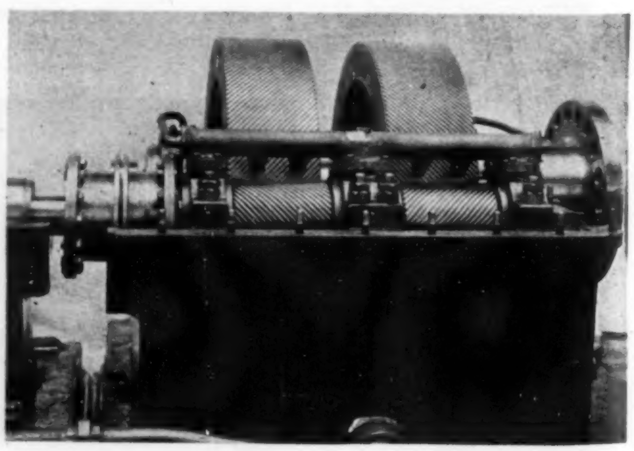


FIG. 6

Fig. 6—Type of oil seal developed for use with ball bearings

Fig. 7—Heavy duty speed reducer showing oil circulating manifold

Fig. 8—Sheet metal oil retaining casing for silent chain drives



There are but two classes of lubricant from which to choose, namely, fluid and plastic, as represented by oil and grease. As a guide in the selection of a lubricant for anti-friction bearings, the physical side of the question of oil or grease may be of interest.

Pure mineral oils are first choice, owing to their resistance to oxidation. Being in the fluid state they offer less resistance to the movement between the rolling element and the spacer.

Requirements of a Lubricant

Primarily all that is required of a lubricant in anti-friction bearing service is to wet the affected parts with a thin film. The principal objection to the use of oil is leakage. In almost every case studied, it has been found that too great a depth of oil was provided. When this occurs excessive heating and foaming result. No greater depth of oil should be carried than will half immerse the bottom ball. Oils for this service are selected by viscosity. Since viscosity varies with temperature, it follows that the operating temperature of the bearing must be known in order to prescribe an oil of the correct viscosity. Under normal conditions a bearing will run at from 10 to 60 deg. F. above the surrounding temperature. The type of housing, as well as the cooling effect from adjacent rotating parts will have a decided effect upon the ultimate temperature.

Table I gives a general classification of viscosities. In using this table it must be clearly understood that ambient temperature is a controlling factor in choosing an oil of correct viscosity. As an illustration, ball bearings operating at 250 deg. F. are lubricated with a "bright stock," meaning a filtered mineral cylinder oil of 150 sec. S.U.V. at 210 deg. F.

Lubricant Application—Application of lubricants to ball and roller bearings is not a satisfactorily controlled operation. Basically, the trouble is that one cannot tell by looking at a bearing whether it contains the correct quantity of lubricant or not. As a result, most bearings are over lubricated to such an extent that heating results, owing to increased agitation and drag. The depth of oil is controlled in certain sizes of bearings by installing constant level oilers. In other cases where bearings are inside fan housing and other inaccessible places sight-feed oil cups or wick feed oilers are installed outside and copper tubing run to the bearings. The quantity of oil required for a single-row bearing for $2\frac{1}{16}$-in. shaft at 450 r.p.m. normally is 2 to 3 fl. oz. per week.

Best Results From Continuous Lubrication

Our experience has been that the best results are obtained where bearings can be continuously supplied with clean, fresh oil. Overflow and oil level are controlled by connecting a copper tube to the drain hole in the housing and forming a siphon, the top of the bend controlling the oil level.

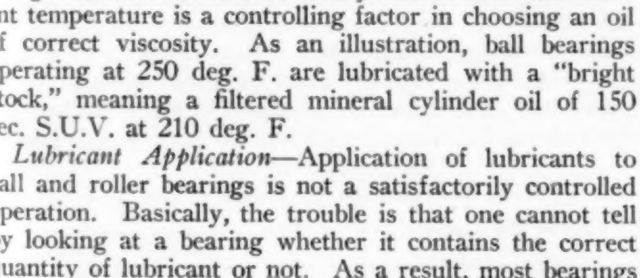


FIG. 8

Table I—Oil Viscosities for Anti-Friction Bearings

Bearing Load, Lb. Radial	Speed, R. P. M.	Viscosity, Sec. S.U.V., 100 Deg. F.
High Speed Ball Bearings		
10—150	4,000—10,000	85—105
150—300	4,000—10,000	150—180
Moderate Speed Ball and Roller Bearings		
50—500	100—600	200—220
	600—1,800	280—310
500—1,000	100—600	320—450

Depending on the duration of operation and the kind of service, bearings should be drained, flushed and refilled to the correct level at least once a year. Bearing caps should be removed and the bearing inspected for the presence of foreign matter.

Metal Oil Seals—In many instances leakage of bearing lubricant is destructive to process work. At the same time it is essential to retain lubricant in the bearing, and prevent the entrance of foreign matter. The seal shown in section in Fig. 6 is designed primarily for ball bearing installations. The seal face or ring is held in contact with the inner race by small compression springs inserted in the housing. The bore of the inner ring is greater than the diameter of the shaft, hence, the only friction surface is the seal ring. The seal may also be used on a steel shaft shoulder. All faces must be lapped to insure tightness. Operating temperature should not exceed 220 deg. F.

Grease Lubrication

Grease may be generally described as a mechanical mixture of soap and a mineral lubricating oil. The soap bases are derived from tallow oil, lard oil, horse oil, red oil (oleic acid) or a blend of two or more of these oils. The lower priced cup greases may contain a blend of cottonseed oil or other vegetable oils and animal oil.

The fatty oils are saponified with the hydroxides of potash, sodium or calcium. In some cases both sodium and calcium soaps are used in combination. Greases supplied to the trade are generally specified as potassium soap grease, sodium soap grease, lime soap grease and "soda-lime" grease.

At a certain stage in the production of the soap, mineral lubricating oils are added. The consistency of the finished product is governed by the percentage of soap, i.e., No. 2 cup grease will run about 9 per cent of calcium soap. The consistency of grease is measured by the depth of penetration of a Penetrometer Cone into a sample of grease. As the name implies, the instrument is conical; it weighs 102.5 grams. When set up its gross weight is 150 grams. To make a reading the tip of the cone is adjusted to contact the surface of the grease under test, which is held at 77 deg. F. When the cone is released the depth penetrated in 5 seconds is read off on a scale graduated in tenths of a millimeter.

The commercial grades of cup greases together with the penetrometer number corresponding to the grade numbers are given in Table II. In practice the numbers shown will vary about 6 per cent.

In the selection of a grease for ball or roller bearings,

it is generally conceded that the sodium soap greases are superior, owing to their higher stability. Several of the leading grease producers are, however, using both soda and calcium soaps in their better-grade products. It is advisable to use only the best greases in ball bearing service, as in this material a better oil is used than in the cup greases. It should be emphasized that no grease is better than the grade of oil employed.

Where operating conditions demand grease lubrication, Table III may be used as a guide. It is a good practice to use greases of high penetration as they are less likely to channel than those of low penetration. Incidentally, it is good practice to inject a small quantity of oil of not less than 200 sec. S.U.V. at 100 deg. F. into the housing, instead of adding more grease. This method keeps the grease soft while at the same time it prevents channeling.

Table II—Grease Grades Corresponding to Penetrometer Numbers

(Grease Penetrometer Numbers, A.S.T.M. D-217-33T)

Grade	Number	Grade	Number
0	350	3	200
1	300	4	150
2	250	5	125

Lubrication of Speed Reducers

Lubrication of gearing, as in speed reducers, differs in a number of respects from that of bearings, but is no less essential. High-speed, heavy-duty gear sets with helical or herringbone gears, for example, are expensive pieces of equipment. Yet, no matter how accurately they are built, their operation depends entirely upon lubrication. Straight mineral oils of 500 to 750 seconds viscosity are successfully lubricating speed reducers, equipped with the above type of gears.

Oils of lower or higher viscosities may be selected, depending upon ambient temperature. Oil should be changed at least once per year, depending upon operating time and conditions. In place of setting an arbitrary time for changing, samples should be taken at four-month periods and examined in the laboratory for viscosity, acidity and the presence of foreign matter. If filtering indicates the presence of solid matter, the sample should be ashed for identification.

In the operation of reducers, heating above normal is at times a source of worry. If the unit is being operated at rating and heating occurs, the cause may be carrying the oil level too high. Just as in ball bearings, a high oil level will cause excessive foaming and this foam apparently acts as an insulator. Units as shown in Fig. 7 do not experience this trouble, as they are lubricated by a pump circulating system. The oil is delivered to the gears at the point of meshing by suitable nozzles attached to a header. In some instances no oil is carried in the housing, the supply being in an auxiliary tank. A pump forces the oil from the tank through a filter and heat exchanger to the nozzles. After passing through the gears, the oil flows to the tank by gravity.

Table III—Recommendations on Greases for Anti-Friction Bearings

(Sodium-soap-base grease recommended for all cases)

Bearing Service	Penetrometer No.	Temperature, Deg. F.
High Speed	320—340	up to 130
High Speed	280—300	150
Moderate Speed	210—230	200
Moderate Speed	320—340	up to 130

Lubrication of Chain Drives

Roller and silent chains operate longer, are more efficient and require less attention if operated with a proper supply of oil, in a dustproof, oil-retaining casing, than if allowed to run exposed with little or no attention. We have found that a silent chain operating without any lubricant has an ultimate life of 72 hours before destruction. A silent chain hand lubricated with moderate attention may last up to 10 years, while we have in service inclosed silent chain drives operating in excess of 18 years.

A silent chain drive from a 15-hp. motor to a fan costs about $75 without a casing. With reasonable care the annual cost for such a drive, based on a 10-year life, will be $7.50. For an additional $25 the drive can be inclosed in an oil-retaining casing, making the total cost of the drive $100. Assuming a life of 18 years, the annual cost of this drive will be $5.50. Even so, the comparison is unfair to the oil-retaining casing because nearly all states require a safety guard to be placed around a chain drive. Therefore, the cost differential between an open drive with a guard and an inclosed drive is not as much as is indicated and the savings are even greater.

Lubricant Selection—The tendency of many operating men is to use heavy cylinder stocks or greases to lubricate roller and silent chains. These are not satisfactory lubricants for they are too viscous to penetrate. A lubricant must be light enough to penetrate to the pins, yet heavy enough to withstand the pressure between the chain and sprocket teeth. Table IV shows the proper viscosity of lubricant to be used for both inclosed silent and roller chains at various temperatures. Fig. 8 shows the method of lubrication when employing an oil-retaining casing. The oil level should be maintained so that the chain will dip into the oil not more than ½ in. If the level is carried too high excess foaming and heating will result.

Table IV—Lubricants for Inclosed Chain Drives

Ambient Temperature, Deg. F.	Approximate Viscosity, Sec. S.U.V. at 100 Deg. F.
Up to 90	300—320
90—130	500—520
Above 130	730—750

Open chain drives should be removed and washed in kerosene oil at periods depending upon the operating conditions. In a dirty or dusty atmosphere, the chain should be removed at least once in two months.

Of necessity, open chains are hand lubricated. Good results are attained by applying oil to the tooth side with a brush, while the chain is idle. If this is not convenient, a thin stream of oil can be applied during operation. Naturally, some judgment is required in this operation, or excess oil throwing will result. Chains running above 1200 f.p.m. may be lubricated with a cylinder oil. At lower speeds a 50-50 blend of cylinder oil and engine oil will give good results. Some engineers lubricate with grease, which is satisfactory on the surface but does not penetrate. Since the greatest wear is on the pins, a lubricant must be applied that will reach these points.

SO_2 Chart for Low Concentrations

By D. S. DAVIS
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JOHNSTONE and Leppla (*J. Am. Chem. Soc.*, 56 1934, p. 2233) have presented valuable data on the solubility of sulphur dioxide in water under low partial pressures of the solute. Their investigation covers a partial pressure range of 0.2 to 10 mm. mercury and a solubility range of 0.2 to 2.1 grams of SO_2 per kilogram of water. These studies were made at 25, 35 and 50 deg. C., so that, except when working at these same temperatures, one who is desirous of using the data is faced with inconvenient interpolation between curved and widely spaced pressure-solubility isotherms.

The accompanying alignment chart extends the utility of the studies in question since it permits interpolations to be made along closely graduated scales with rapidity and sufficient accuracy. The use of the chart is illustrated by the broken line which shows that 0.97 gram of sulphur dioxide will dissolve in 1,000 grams of water at a temperature of 35 deg. C., when the partial pressure of SO_2 is 5 mm. mercury.

If it should be desired to express the solubility on the basis of 1,000 grams of solution, this can readily be accomplished with the formula, $\sigma = 1{,}000\ S/1{,}000 + S$, where S is solubility per 1,000 grams of water and σ is solubility per 1,000 grams of solution.

Deviations of Calculated From Experimental Data

Temperature, Deg. C.	Partial Pressure of SO_2, Mm. Hg	Percentage Deviation in Solubility, Calculated From Experimental
25	0.91	−0.8
	1.74	1.3
	2.03	−1.0
	5.10	−0.1
	6.92	−0.7
	10.26	0.5
35	0.78	−1.9
	1.89	2.3
	3.13	8.4
	4.41	1.5
	7.26	−1.7
50	1.75	0.3
	2.91	0.0
	4.09	−6.3
	6.68	0.3

Correlation of Johnstone and Leppla's data has been effected by means of the equations:

$$S = m\,p^n$$

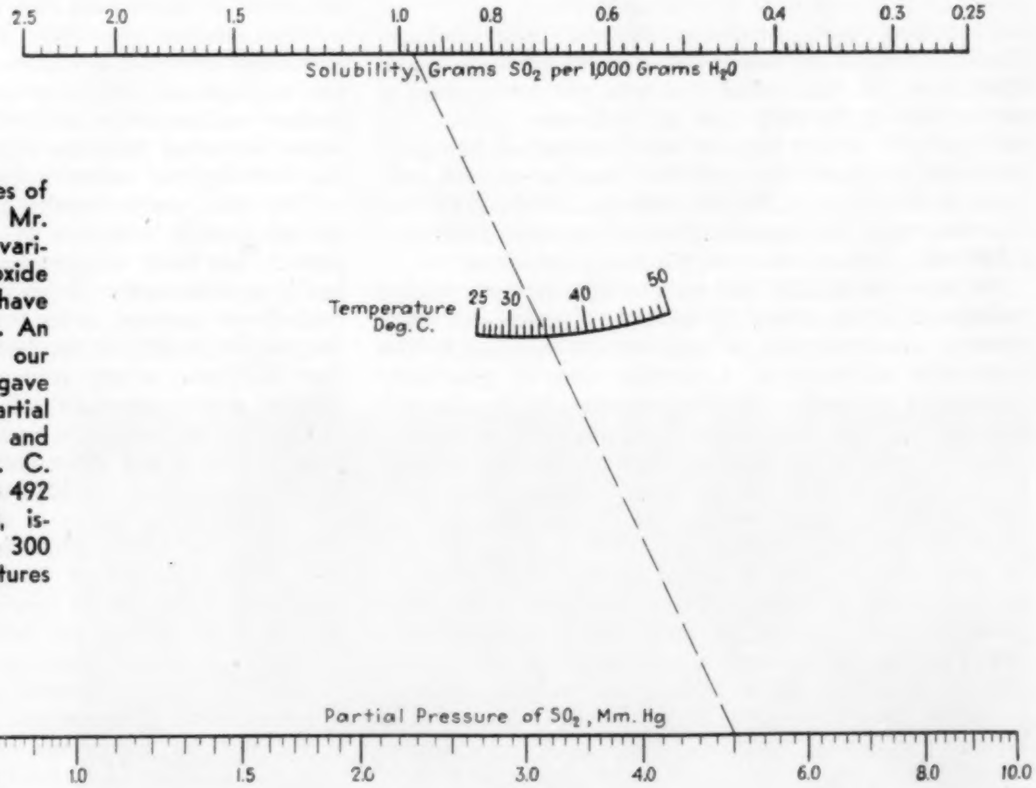
$$m = 0.844 - 0.0212\,t + 0.000172\,t^2$$

$$n = 0.482 + 0.0149\,t - 0.000247\,t^2$$

Here S is solubility expressed in grams SO_2 per 1,000 grams of water; p is the partial pressure of SO_2, in mm. of mercury; and t is the temperature in degrees C.

The degree of agreement between the chart and the original data is shown by the table which lists the percentage deviations of the calculated from the experimental values of the solubility at the experimental pressures and temperatures.

It will be seen that the chart agrees with the experimental data to within 2.5 per cent except for two instances. Data at these points had been rejected in the correlation procedure as being erratic.



This is the third of a series of nomographs prepared by Mr. Davis to correlate data on various ranges of sulphur dioxide solubility. Higher ranges have previously been presented. An article on page 615 of our November, 1932, issue gave data on solubilities at partial pressures up to 700 mm. and temperatures to 40 deg. C. A second article on page 492 of our September, 1935, issue covered solubilities to 300 grams per liter at temperatures to 120 deg. C.—Editor.

Rectifiers Succeed in Westvaco's Caustic Soda Plant

By W. E. GUTZWILLER

Allis-Chalmers Manufacturing Co. Milwaukee, Wis.

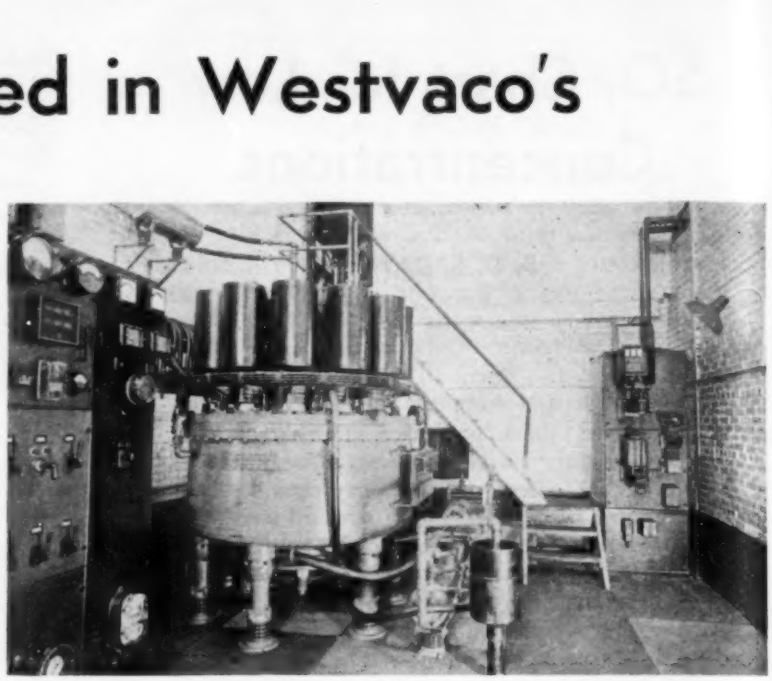


Fig. 1—One of two rectifier tanks in plant of Westvaco Chlorine Products, Inc.

MERCURY-ARC power rectifiers have successfully and extensively been used for years in European and Canadian electrolytic plants where there are today over 350,000 kw. in commercial service. About two years ago the first rectifier installation was made in an American electrolytic plant. In 1934, when Westvaco Chlorine Products, Inc., needed additional converting equipment for its 250-volt chlorine plant, the management, recognizing the economic advantages of rectifiers and their future importance as a converting unit, decided to install a 2,000-kw. rectifier in order to gain experience with this relatively new type of apparatus.

This first unit, furnished by the Allis-Chalmers Manufacturing Co., was installed in Westvaco's South Charleston, W. Va., plant and was put in commercial service during the early part of September, 1934. The principal part of this rectifier unit consisted of two grid-controlled rectifier tanks with their auxiliaries, each tank rated at 4,000 amp., 250/500 volts d.c., 1,000/2,000 kw. The two tanks are supplied from a common 2,000-kw., 2,300-volt, 3-phase, 60-cycle outdoor transformer.

In order to explain the reasons for the two voltage ratings of this rectifier, let us briefly review the basic inherent characteristics of mercury-arc rectifiers. The conversion efficiency of a rectifier tank is practically constant at all loads. This is accounted for by the fact that the kilowatt loss in the rectifying arc, which is a direct measure of the efficiency, is approximately proportional to the rectifier direct-current output. The alternating-current voltage supplied to the rectifier and the rated direct-current voltage have but little to do with the rectifying process. Rectifiers are rated according to current output. Consequently, the kilowatt rating of a given type of rectifier increases about proportionally with the direct-current voltage and as the arc loss is not affected by the operating voltage, the rectifier efficiency is higher the higher the direct-current voltage. The Westvaco engineers took full advantage of this peculiar characteristic and had the transformer of this first unit arranged with a double secondary winding. These windings, as well as the rectifier tanks, are designed so that the two 4,000-amp. tanks can be fed in parallel at 250 volts d.c., equal to 1,000 kw. each, or 2,000 kw. total. The arrangement is shown in Fig. 2.

The secondary windings may also be connected in series and thus supply a single rectifier tank at 500 volts, 4,000 amp., or equal to 2,000 kw., as shown in Fig. 3. In doing this it was the intention of the Westvaco engineers at some future date to connect twice the number of chlorine cells in series and thus operate at 500 volts d.c., with an appreciable gain in efficiency and a doubling of the rectifier capacity. This arrangement has the advantage that the substation output can be doubled at the expense of only one additional 2,000-kw. transformer and one set of a.c. switching equipment. Fig. 3 shows in dotted lines the additional equipment required for doubling the station output.

The two rectifier tanks are provided with manual voltage control by means of energized grids in the arc paths. The total voltage range obtained with this control is approximately 15 per cent of rated voltage. This control was essential owing to the necessity of paralleling the rectifiers with a d.c. bus, to which are connected four 3,150-kw. rotary converters, one 1,500- and one 750-kw. motor generator set.

The rectifier tanks are arranged for water cooling by means of a closed recirculating cooling system and a water-to-water heat exchanger. With this arrangement the same cooling water is used over and over again while the raw water, which in this case is pumped out of a river, does not get in direct contact with the rectifier tanks. The cooler tubes are arranged so that they can easily be flushed out without interfering with the operation of the substation and are corrosion-resisting.

The 2,300-volt a.c. power to the rectifier transformer is controlled by a cubicle-type oil circuit breaker situated in the near-by power house, and remotely controlled from the rectifier substation.

There is a 6,000-amp. single-pole, solenoid-operated, d.c. breaker connected in the positive lead of each rectifier tank. The negative lead is provided with a 6,000-amp. knife switch.

All the rectifier auxiliaries are supplied from a control transformer bank, consisting of three 7½-kva. single-phase, 2,300/230/115-volt transformers.

The rectifier equipment was temporarily installed in an available building adjacent to the converter room. The total inside floor space of the rectifier substation is 16½x31½ ft. Fig. 1 shows half of the rectifier room, with part of the control board to the left and one of the rectifier tanks in the center. To the right of the rectifier the water-to-water heat exchanger and circulating pump are located. In the righthand corner of the substation the 6,000-amp. single-pole d.c. breaker and knife switch for one rectifier are visible.

Starting the rectifier unit is accomplished by simply closing the a.c. and d.c. breakers, closing the control switch for the arc-striking device, and starting the cooling-water circulating pump. There is no regular attendant in this rectifier substation. The operator of the adjacent rotary converter room makes an inspection of the rectifier station once every hour for the purpose of taking log readings and occasional adjustment of the rectifier load with the grid control rheostats. The operating engineers consider a maximum of three inspections per 24 hours ample for satisfactory operation of a rectifier of this type.

The major protective devices of this rectifier unit consist of a.c. overload and d.c. reverse-current protection, and protection against vacuum and cooling water failure, and excessive temperature in the rectifier and transformer.

According to the operating staff, during the 21 months of commercial operation of this rectifier there has been no substation shut-down which could be attributed to failure of the rectifier equipment. In spite of the use of river water for cooling, which at times contains considerable foreign matter in suspension, the water-to-water heat exchangers have never been opened for cleaning. Two or three times per day the cooling water is turned on full force for a moment in order to flush out any sediment which may have collected in the tubes of the coolers. In spite of the fact that the pressure in the water system at times is subjected to wide fluctuations there has been no service interruption on account of an insufficient supply of cooling water.

The operators claim that grid control in this installation has been found to be as reliable as the field control on a d.c. generator. No arc-backs in the rectifiers have

Summary of Operating Data on Westvaco Rectifier Installation

(Totals and averages for 21 months' operation)

Total 2,300-volt a.c. input to rectifier transformer..	31,303,200 kw.-hr.
Total 2,300-volt a.c. input to rectifier control transformer	179,680 kw.-hr.
Total 2,300-volt a.c. input into rectifier and auxiliaries	31,482,880 kw.-hr.
Total rectifier d.c. output (both tanks)........	28,375,300 kw.-hr.
Total conversion loss, including power consumption of rectifier auxiliaries	3,107,580 kw.-hr.
Overall conversion efficiency, including rectifier....	90.14 per cent
Average d.c. operating voltage (approx.)........	260 volts
Guaranteed overall full-load efficiency at 250 volts..	88.4 per cent
Total time rectifiers in commercial operation in 21 months period (est.)........	15,200 hours
Average d.c. load of rectifier set (est.)........	1,870 kw.
Substation load factor........	93.5 per cent
Total power consumption of all rectifier auxiliaries, metered on 2,300 volt side of control transformer, per cent of station input........	0.57 per cent

been recorded during the 21 months of commercial operation, nor have a.c. line troubles in any way directly affected the rectifiers.

It is instructive to examine a summary of operating data on this installation. The accompanying tabulation taken from the substation log sheets as of May 19, 1936, covers totals for the entire 21 months. It is interesting to note that at the relatively low d.c. voltage of 260 volts, the overall conversion efficiency of the rectifier substation has nevertheless been above 90 per cent.

The maintenance cost during the 21 months has been negligible, consisting mainly of replacements of a few small control resistors and the furnishing of a small amount of make-up oil for the vacuum pump and make-up mercury for rectifier seals.

As a result of the highly satisfactory performance of this initial rectifier installation, Westvaco has recently purchased two additional rectifier sets, each rated 3,000 kw., 500 volts d.c. Simultaneously with the installation of this new equipment the two old 250-volt rectifier tanks and their transformer will be reconnected to 500 volts, thereby raising the rating per tank from 1,000 to 2,000 kw. with a 5 per cent increase of conversion efficiency. A second 2,000-kw. transformer has also been purchased to take care of the increased output of the old tanks.

These first mercury arc rectifiers used for electrolytic work have, beyond all doubt, demonstrated their suitability and economy for electrolytic work. Their principal advantages over converting equipment of the rotating type for this class of service are low maintenance cost, on account of immunity to chemical fumes, absence of heavy moving parts, brushes, commutators and bearings, high overall conversion efficiency, simple operation, protection and voltage control and unusual stability during a.c. system disturbances.

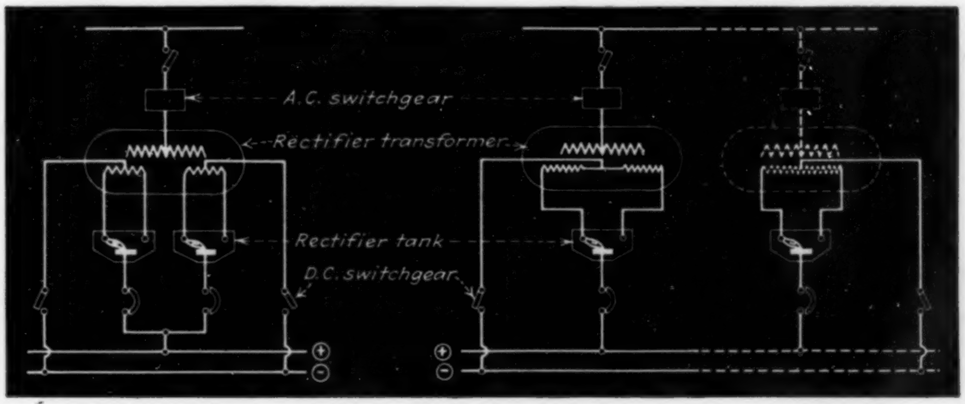


Fig. 2, Left — Simplified diagram of rectifier unit with parallel-connected secondary windings for 250-volt operation

Fig. 3, Right — Series-connected windings for future 500-volt operation, dotted lines showing additional equipment for doubling power output

How a Chemical Engineer Looks at The Farm Problem

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THE FARM PROBLEM is not a new one. It has occupied a prominent place in the economic and social history of practically every nation. Like every other large industry upon which large segments of the national population depend directly for their livelihood and well-being, agriculture encounters difficulties in fitting itself into the intensely varied and complicated patchwork that makes up the nation's industrial fabric. The problems involved in the fitting process are greatly accentuated by the national and international dislocations of economic equilibriums which follow social and political upheavals. Many times these difficulties are further accentuated by the tendency of an industry to follow tradition-bound policies that are ultra conservative and which do not provide means to meet new conditions in a world that is being rapidly changed by the applications of the discoveries of science.

Such seems to be the case of agriculture at the present time. The collective ills that have arisen in American agriculture in the last 20 years as a result of these causes constitute the present farm problem. It is the subject of daily discussion everywhere, and as usual, unfortunately, it has become a political football. Ignorance of underlying causes and loose thinking have led to many impractical attempts at its solution.

What are the real facts that have led to the farm situation as we find it today? Let us look at them and analyze them dispassionately. To do this I should like to present two pictures, first, the farm situation in 1914, and second, its situation in 1936.

American Farm in 1914

In 1914 the American farm was an independent, self-supporting and profitable productive unit in our industrial system. In 1936 this same farm is a largely dependent and profitless productive unit in the same industrial system. What are the changes that have taken place in 20 years that have brought this great industry to the low estate in which we now find it?

From the chemical engineer's point of view the production of agricultural products is essentially a manufacturing business. It requires: (1)—A practical process. (2)—A plant with adequate machine equipment. (3)—An economical power supply. (4)—A trained operating personnel. (5)—Sufficient working capital. (6)—A stable market. In 1914 this great industry was equipped with all of these items. It was the most independent of our industries in a peaceful world.

What did it produce at that time? There were five basic products:

1—Carbohydrates
- a—Starches from grains and tubers
- b—Sugars from sugar cane and root crops
- c—Cellulose from grasses, fiber plants and trees
- d—Manures from grasses, legumes, straw, etc.

2—Proteins
- a—Animal products such as meats, milk, hides, oils, etc.
- b—Animal fibers such as wool, hair
- c—Vegetable proteins
- d—Manures—Animal waste

3—Fats
- a—Butter
- b—Lard, tallow, greases, animal oils
- c—Vegetable oils

4—Power
- a—Horses
- b—Mules

5—Operating Personnel
- Principally the farmer's family

These were the traditional farm products. With the exception of item (5), they were obtained in greatly increased yields from the soil by improved methods developed by agricultural experiment stations whose principal business was to make two blades of grass and two ears of corn grow where only one grew before. The products were marketed at home and abroad for food, clothing and power purposes at prices that made the farm profitable. The average value of farm land had been gradually increasing for many years. Investments in farm lands were considered to be the highest grade. The farm plant was maintained in good condition for maximum production. The agricultural industry in general was sound and the outlook good. It should be particularly noted that the farm at this time produced the greater part of the power used by the nation. In fact, it may be truthfully said that from colonial times to this period the power required to build the nation was produced principally on the farms. Such was the picture in 1914.

Presented before the second Dearborn Conference of the Farm Chemurgic Council, Dearborn, Mich., May 12, 1936.

In 1936 the American farm is planting practically the same crops that it produced in 1914. It is operating, however, under vastly changed conditions in a war-torn world and in a country whose industries are disorganized by depression and where chemical and physical science, particularly synthetic organic chemistry and its engineering applications, are daily changing the course of industry and the habits of the people. Two things of major importance have happened: One, scientific research and the applications of its discoveries have developed new tools for the farm plant and substitutes for many of its products which have wrought fundamental changes. Two, national and international political and governmental changes of policies have restricted home and foreign markets.

Let us examine the list of basic farm products and see how these two fundamental changes have affected their production. Power will be considered first.

Power on the Farm

The farm production of this product has undergone such a revolutionary change that it has been a prime factor in developing the present situation with respect to some of the others. The introduction of the explosion engine as a prime mover for farm machinery, pleasure vehicles, trucks, excavating, grading and construction machinery has had a profound effect upon the whole agricultural industry. This development has done more to remove the drudgery and hard work of the farm than all other improvements in previous history. However, it has had another effect. It has almost completely eliminated one of the farm's most profitable products, power, and changed its status as a servicing industry to other industries. The number of horses and mules on the American farms has dropped since 1920 from 24,000,000 to 14,000,000, a decrease of 10,000,000 units, and is decreasing at the rate of 450,000 per year now. The off-the-farm demand for horse power has completely disappeared. A valuable market has been lost. In fact, the farmer does not produce nearly enough power for his farm operation. He must buy it. Along with the decrease of 10,000,000 farm animals has gone the demand for the products of 50,000,000 to 80,000,000 acres of land that were needed to feed them. No new use for these products has been provided. To add to the marketing difficulty, the new mechanized farm equipment has greatly increased the farmer's power to produce.

Another serious consequence of the disappearance of 10,000,000 horses and mules from the farms is the annual loss of from 50,000,000 to 60,000,000 tons of valuable organic manure which was used to maintain land fertility. There has been no compensating replacement of this fertilizer. The productivity of the farm is not being maintained.

The automotive and petroleum industries are deeply indebted to agriculture. They have profited immensely while it has lost. Any steps that may be taken to enable the farmer to regain at least a part of the power market which he has lost are steps in the right direction. To regain a profitable market for the products of from 50,000,000 to 80,000,000 acres of grain-raising land by utilizing them for farm power purposes will do much to improve the economic condition of the whole industry.

What has happened to the other farm products during this period? The production of starches and sugars has greatly increased the world over through use of mechanized farm equipment. It has increased through demand by every nation to become self-sustaining with respect to food requirements. This has resulted in surpluses and loss of export markets. Very few important non-food uses have been developed.

Cellulose products, particularly cotton, have been hard hit. Technological developments resulting in new products that have displaced cotton to a large extent have created a serious condition in that industry. The new synthetic textile fibers that are being made from wood pulp have made deep inroads in the cotton textile business. There is every reason to believe that new fibers will be developed having superior mechanical properties that will further displace this important staple. The loss of export trade in this commodity has added further to the economic distress of the cotton farmer. In cotton raising and in the manufacturing of cotton products, as in the agricultural industry in general, staunch conservatism has been the rule. Practically no research has been done to develop new uses to meet changing conditions. Unless there is a change of attitude toward research soon, the outlook will not be good. There are some signs of an awakening.

A change in the diet program of the whole population of the country by including large quantities of green vegetables and fruits has displaced meats and starches noticeably. The increased use of vegetable proteins is growing continually.

What Has Happened to Farm Products?

The use of milk is increasing, but the use of hides as leather has greatly decreased. Harness for the 10,000,000 horses and mules that have been displaced was a big item in leather consumption. Artificial leathers and other fabrics have displaced it for upholstering. Direct connected motors, silent chain drives, gears and cotton fabrics have displaced it as belting. Few new uses have been developed. The use of animal fibers for textiles is decreasing. The many improvements in home and office building that have taken place through the development of new structural materials, insulation, air conditioning, etc., and in transportation, such as the closed, heated automobile, have made heavy woolen clothing much less necessary. The new synthetic textiles with superior qualities for many purposes have also displaced woolen textiles. Practically no new uses have been developed to compensate for these losses.

With the exception of butter, many new products have come into extensive use as substitutes for the animal fats. The production of lard substitutes made by hydrogenating cottonseed oil, fish oils, tropical oils, etc., has developed into a large business. The use of tallow has been greatly restricted. The development of new synthetic detergents bids fair to cut down to some extent the use of soaps made from animal and vegetable oils.

The effects of the great changes that have taken place in agriculture upon family life on the farm are important. With mechanized equipment the farmer does not

need the large family that was necessary to operate the farm plant without hiring outside labor. The decrease in the size of farm families has been noted by many students of the farm problem. The farm in 1936 is much less of a factory than it was in 1914. There is much less of the processing of the raw materials of the farm such as the making of butter and cheese, baking bread, preserving fruits and vegetables, butchering of animals and the curing of meats. The farmer has become almost as large a purchaser of foodstuffs and other necessities of life as his brother in the city.

The agricultural industry in 1936 finds itself in a changed world and it is quite improbable that the farm will ever again be independent and self-supporting. Scientific developments will continue that will tend to further restrict the use of traditional farm crops. The farm will continue to produce the principal foods for animal and human consumption. It seems certain that further improvements in production methods will come that will tend to increase crop surpluses rather than reduce them. It is not likely that new food uses will be developed in the country that will consume a large part of the surpluses. With the rapidly growing tendency the world over toward intense nationalism, it is doubtful if the farmer in the near future will be able to dispose of his crop surpluses in export markets.

What course should be followed to solve the present farm problem and minimize the effect of new ones that will arise in the future? First of all, the farmer and the agricultural industry as a whole should fully appreciate the fact that controlling conditions under which they exist are changing rapidly and will continue to do so and that it is necessary to anticipate the trend of the changes and make provision for adjusting themselves to them as they take place. Many of these changes will be brought about by discoveries in the field of applied chemical science. To solve its problems agriculture should take a leaf out of the notebook of industry. Research must be undertaken in order to develop nonfood uses for standard farm crops in industry. New crops must be developed that will have use as raw materials in industry. Instead of making two blades of grass or two ears of corn grow where one grew before, two new uses should be developed for the old crop and two new crops to replace each old useless one.

Break Up Nature's Molecules

Agriculture should find out how to break up nature's big molecules step by step. These molecules with molecular weights varying from 10,000 to as high as 1,000,000 are beyond doubt veritable storehouses of useful products and are the units with which many of the farm crops are built. This field has tremendous possibilities. Investigations should be made of the action of organic catalysts such as the enzymes and methods of producing and using them should be found. The farmer must keep his eye continually on the chemist and chemical engineer. Sometime someone will discover how to produce chlorophyll cheaply and find out how to use it in industry. That discovery will have far-reaching results. Investigations of the dehydrogenation of fats for the production of unsaturated compounds should open up new uses for this class of substances. Studies of the common weeds in each locality with the idea of utilizing them as valuable farm crops for use in industry should be made. The action of plant hormones for stimulating the rate and quality of plant growth, particularly for producing rapid growth of trees, should be investigated.

The agricultural experiment stations which ever since their establishment have been devoting most of their time and energy to devising methods for increasing yield and qualities of standard farm crops should reorganize their research program in the light of the new trends in the scientific and industrial world. These institutions should be staffed with the keenest research minds under the leadership of directors who have a vision of the course of scientific developments and who have bold imaginations and an appreciation of the practical requirements for industry. These research organizations must be able to compete with and keep abreast with the discoveries and developments that will be made in the powerful research laboratories of industry. If agriculture is again to be prosperous and if industry is to continue its prosperity they must both work together and utilize the fruits of their research laboratories for their mutual interest. This is the solution of the farm problem as the chemical engineer sees it.

Casein Imports Into U. S. Advance Rapidly

IMPORTS into the United States of casein have advanced in recent months with France supplying more than half the total, according to the Department of Commerce. During the first five months of the current year a total of 8,025,000 lb. of casein or lactarene have been imported compared with only 823,500 lb. during the corresponding period of 1935, preliminary statistics show.

Ordinarily Argentina supplies the bulk of our casein imports but during the current year France has taken the lead with 4,434,000 lb. against 2,540,000 lb. from Argentina. Smaller quantities were received from Canada, Brazil, New Zealand, the Netherlands, Germany, Belgium, and the United Kingdom, it was stated.

The increase in imports of casein since the beginning of the year is of interest particularly in view of the fact that the United States had in recent years attained a high degree of self-sufficiency in connection with its casein requirements. During the decade ending with 1930, though our domestic production was increasing rapidly, reaching a peak of 42,000,000 lb. during the latter year, more than half our domestic requirements of casein was obtained through imports. In 1931, however, imports decreased sharply to 3,000,000 lb., or less than 10 per cent of our estimated domestic consumption during that year, and in 1932 only 1,475,000 lb. were imported. Since then casein imports have continued small with the exception of 1933 when 8,000,000 lb. were imported, and in the first five months of the current year when receipts approximated 8,000,000 lb.

Casein is widely produced throughout the United States. The domestic production in 1934, the latest year for which data is available, amounted to 37,331,000 lb. compared with 24,087,000 lb. during the preceding year.

"The Four Horsemen" Create Jobs For Chemical Engineers

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A GREAT many opportunities for technically trained men exist in the process industries. They include not only those much-discussed ones "at the top" and jobs at less dizzy heights in the fields of research, development, design, construction, operating, marketing, sales, purchasing, etc., but also those fields which may be regarded as the life saving jobs of the process industries. No jobs are more important than those related to decreasing the truly sinister dangers, hazards, pestilences and annoyances which are connected with these industries. It is with this belief in the importance of the work that can be done, the jobs that can be sought and secured, and the careers that can be carved by chemists and chemical engineers that attention is focused here on these depressants of efficiency, economy and safety in the process industries.

The Four Horsemen of the Apocalypse—Fire, Famine, Pestilence and Death—the Biblical scourges of ancient times, have their counterparts and parallels in the process industries. The parallels of these scourges are far less serious than their progenitors of history and also much less serious than their ancestors in the process industries on account of the wholehearted intensity with which the chemical industry has been battling them for a number of years. Within the past decade, particularly, the process industries have been directing a very appreciable effort to the lessening of these hazards in their plants. Despite the advances that have been the results of these efforts, serious problems still remain where these Horsemen are concerned. The development of prophylactic and therapeutic measures, devices, controls, and equipment for these problems is a fertile field for the well-trained, imaginative, and logical chemist and chemical engineer. It is hoped that this article will be of assistance in emphasizing the need of the process industries for a full appreciation by engineers of the opportunities that exist for combating these hazards.

Fire—The field of fire protection in industry offers attractive futures for the young graduate and for the man who has been out of school for a few years and obtained general chemical experience that is valuable for fire-protection work. This type of work requires a broad and thorough knowledge of not only fire-protection equipment and principles but also a good knowledge of chemistry, particularly, of the physical chemistry of inorganic and organic chemical compounds; and of such properties as: vapor pressures, flash points, fire points, and explosive and fire limits as regards mixtures with air, and other oxygen containing gases, liquids and solids. In addition, a working knowledge of chemical engineering is desirable and, in some cases, essential for the proper handling of the problems that frequently arise. With the increasing use of foams in fire extinguishing equipment, a knowledge of such colloidal systems and phenomena is also desirable. It will be seen, therefore, that the technical men who enter fire protection work have ample need for detailed technical information and that there is no danger that they will be entering a non-technical profession which would not utilize their formal training.

The loss of property and the threat to the continued production of a plant are constant possibilities and, as such are a continual worry of industrial chemical managements. Insurance is generally carried, either with an insurance company or within the organization, but the insurance rates are high and insurance coverage cannot include compensation for all the losses that are directly and indirectly caused by fires. The process industries have done a good deal to eliminate causes of fires and to supply their plants with modern fire prevention and fire fighting equipment. However, the losses caused by fires are still large and much remains to be done before the dangers of fire are reduced to the desirable minimum and before the control of fires, once started, is entirely satisfactory. The least that can be accomplished by a further development and application of prevention and control of fires is a reduction in the present serious losses of property and of production capacities of plants.

Opportunities in Famine Prevention

Famine—Famine may be defined as "an extreme scarcity of a material or thing." The potential sources of this Horseman will suggest to chemists and chemical engineers fields of effort which they should consider for their future technical efforts and ambitions. Many of the possibilities are frequently not considered by the young engineering graduate. The opportunities in famine prevention or famine insurance would seem to be great and appear to be much more free from competition than some of the older fields such as: operating, research, technical control work, and the like.

It is not difficult to mention a large number of "mate-

rials or things," a scarcity of any one of which is an extremely serious matter to an organization. Some of the items that are critical as regards the proper continuous functioning of a business and a dearth of which may be more than embarrassing, are given below:

Raw materials or semi-finished products: Quality, reserve, proximity to consuming points, competitive sources.

Labor: Supply, nationality, quantity, diversity, intelligence, wage or salary scale, efficiency.

Water: Sources, quality, quantity, costs.

Power: Sources, dependability, kinds.

Fuels: Kinds, quality, quantity, alternate sources.

Transportation facilities: Kinds, railroads, steamship, barges, automobiles, canals, air, costs.

Markets: Kinds, areas, quantities.

Other industries: Consuming, feeding, and competitive industries.

These potential famine sources or causes represent a few of the many matters that must have a thorough consideration and planning in order to be avoided.

Safeguarding Future Development

Both the young and the old technical men are more than ever conscious of the importance of definite plans for the continuous training and development of men, and are more than ever conscious of the fact that a lack of suitable men in the key positions of an industrial effort is a famine of the worst possible sort. The technical man should appreciate the importance of himself and others in order that he may guide himself and others in the proper development and suitable placement of the men that will be his subordinates in his future career. By safeguarding their development, he is protecting his own development and career; failure so to consider this important factor of his industry and organization will penalize not only them but also will penalize his own advancement and accomplishments.

Pestilence—This third Horseman, as far as the process industries are concerned, is represented by a large number of hazards, nuisances, dangers, and sources of reduced profits. In the fermentation industries, it is represented by foreign bacterial cultures producing materials that are objectionable and reduce the yields of the desired products. In the production of lactic acid, for example, by the fermentation of starches, sugars, etc., foreign bacteria will frequently decrease the yield of lactic acid and will increase the amounts of other acids which are objectionable from the standpoint of odor, color, and uses.

Pestilences in the catalytic manufacture of sulphuric acid are arsenic and/or halogen compounds in the sulphur. These may cause the expenditure of large amounts of money for their removal in order to avoid contamination of the acid product, or to avoid the poisoning of catalysts in the contact process. The presence of sulphur and sulphur compounds is deleterious to many of the catalysts normally used in the commercial hydrogenations of coal, mineral oil, vegetable oil, and in a large number of the catalytic organic hydrogenations that are so widely practiced now in the process industries. The presence of traces of such materials as phosphine in high-temperature catalytic oxidations, such as the oxidation of ammonia to nitric acid, will markedly decrease the efficiency and the economy of the processes. Many similar pestilences could be mentioned in other catalytic reactions, but these will indicate the important extent to which such pestilences affect industries using catalysts.

Corrosion and abrasion are pestilences which continually confront the chemical industry and the industrial chemist and engineer. From the standpoints of expense to industry, of safety in the manufacturing and use of chemical products, corrosion and abrasion are undoubtedly the principal offenders in the family of pestilences and take their annual toll of millions of dollars from the manufacturers and users of chemicals. Much research is being done to alleviate, if not to prevent entirely, such troublesome problems and considerable progress has been made by the combined efforts of metallurgists, physicists, chemists, and engineers. Much remains to be done, however, before it can be said that we have the situation well in hand.

Equipment failures are a too-frequent cause of unsatisfactory, inefficient and uneconomical production in the chemical industries. Aside from corrosion and abrasion, the failure of equipment may occur through limited capacity or occasionally excessive capacity, incorrect design as regards the flow of heat, flow of fluids, material transportation, gaskets and packings, sticking valves, and a host of other annoyances which may be petty or may be catastrophic. The problems for the chemist and the chemical engineer implied here embrace both design and construction of more suitable equipment for the process industries.

Many of the pestilences are receiving considerable attention from engineers not only in industry but also in university laboratories. In fact, an appreciable part of the work of the industrial chemist is devoted to pestilences, and these matters will continue to require the services of additional chemists and chemical engineers.

Safety Work Offers Opportunities

Death—There are real opportunities for chemical engineers in safety work in the process industries—opportunities which should be as remunerative and satisfaction-giving to the individual as any others that are usually more often considered as possibilities for employment. The health and safety from injuries and death of employees is a matter of humanitarian, technical and economic interest. Despite the fact that safety conditions in the chemical industries have been greatly improved in recent years, there is still and always will be, a real need for further reduction and if possible the elimination of all hazards in industry. The industrial organizations are definitely and vitally conscious of this need and are to be commended for their present attitude and intensive efforts to improve conditions.

And "death" for an organization or even an industry may be interpreted in other ways than in health hazards and fatalities to its personnel. The health hazards, that is, the economic health or economic conditions, of an organization may properly be included in this general category. This economic health of an organization may be affected favorably or adversely by a number of important factors, such as: attitude regarding and policies of research and development, and care of customers by price policies and by customer research.

Chemical Engineer's BOOKSHELF

The Year in Review

Annual Survey of American Chemistry. Vol. X. Edited by *Clarence J. West*. Published for National Research Council by Reinhold Publishing Corp., New York City. 487 pages. Price, $5.

Reviewed by *Robert L. Taylor*

WITH the 1935 volume, this now well-established chronicle of the year to year progress made in American chemistry celebrates its first decade of existance. It contains better than twice the amount of material presented in the first survey in 1925. While the 25 chapters in the new book offer no change in number from last year, the subjects covered are quite different. This is in keeping with the policy adopted in 1933 of reviewing certain of the topics only every two or three years. Of the subjects covered in the present volume, at least the following ten are of particular industrial interest: ferrous metallurgy, insecticides and fungicides, gaseous fuels, petroleum chemistry and technology, detergents and detergency, cellulose and paper, synthetic plastics, rubber, unit processes in organic synthesis, and chemical economics. A convenient and useful feature is the exhaustive list of references compiled separately at the end of each chapter. Altogether, there are 4,800 citations of recent papers which have contributed to progress in chemistry and industrial technology. These are indexed according to both subject and author.

Mellor Series Addition

A Comprehensive Treatise on Inorganic and Theoretical Chemistry. Vol. XV. Ni, Ru, Rh, Pd, Os, Ir. By *J. W. Mellor*. Published by Longmans, Green and Co., New York City. 816 pages. Price, $20.

THIS LATEST volume of the Mellor series, which leaves only one more to complete the tremendous work begun 14 years ago, is written with the same painstaking thoroughness and accuracy which is characteristic of its famous predecessors. Of the entire 800 pages, some 500 are devoted to a most extensive treatise on nickel. The remaining space is given over to five of the less common members of the transition group of elements, namely, ruthenium, rhodium, palladium, osmium, and iridium. Upon scanning the pages of this volume, one is impressed by the noticeable increase in the use of diagrams and graphical forms of data presentation. This continual striving throughout the series to present information in as clear and concise a form as possible is indeed commendable in view of the fact that the value of the work lies as much in its utility as a ready reference as in the great profundity and extensiveness of its contents.

German Chemical Engineering

Grundriss der Chemischen Technik. By *F. A. Henglein*. Published by Verlag Chemie, G.m.b.H., Berlin. 470 pages. Price, RM. 22.40.

Reviewed by *James G. Vail*

THE SERIES of lectures on chemical technology, of which this volume is an adaptation, were intended for students who have studied analytical and physical chemistry and are familiar with introductory engineering subjects.

The first part deals with the general procedures of chemical engineering, unit operations, and the considerations which determine location and design of chemical plants. The section on the German chemical industry as a factor in national economy will not have special interest for American readers.

The second part deals with specific applications of ten principles over a wide range of inorganic and organic chemical industries—not in detail but with clean and concise descriptions. The material is well organized to show inter-relations of industries and processes. a thoroughly systematic book.

The author is to be commended on his advice and use of diagrams and photographs, of which there are 435. They add greatly to the value of the book. Frequent references to equipment of American design indicates the intention to place credit where it is due.

An aim of the author is to show chemical industry as a synthesis of various branches of science with economic factors—to present a pattern of thought which is the broad philosophy of chemical engineering. Even the non-professional reader will hardly miss the point that study of such matters as patents, profits and transport, as well as pure chemistry and theoretical engineering, are necessary to successful chemical enterprise.

Ost Revised

Lehrbuch der Chemischen Technologie. By *H. Ost* and *Berthold Rassow*. Published by Dr. Max Jaenecke, Leipzig, 941 pages.

Reviewed by *A. P. Hartlapp*

THE REVIEWER has enjoyed reading earlier editions of the "Ost," and thus appreciates the thoroughness of the present revision, which has been brought up-to-date. Many of the best known specialists in their respective fields have contributed generous data to make this compilation outstanding.

The material of chemical technology cannot, of course, be grouped according to chemical elements, but it will suffice to say that the territory covered is very considerable, and well organized. The more important subjects treated are: Coal, coke, illuminating gas, mineral oil, refrigeration, technology of water, sulphuric acid, the nitrogen industry, acids, cement, nitrogen fixation, sugar, rayon, dyes, and metallurgy. The processes described are illustrated by line diagrams, and many calculations, detail drawings, flow diagrams, and general plant layouts are included. There is a comprehensive bibliography of recent German books relating to the respective subjects.

This work is primarily a textbook, but is also of value as a chemical engineer's handbook.

Making Feedwater Fit

Boiler Feed Water Treatment. By *F. J. Matthews*. Published in England by Fisher, Knight & Co., Ltd. U. S. Agent: The Chemical Publishing Co. of New York, Inc., New York City. 242 pages. Price, $5.

THIS book, although concerned primarily with British practice and drawing heavily for illustrative material upon British equipment manufacturers, appears to be a comprehensive and simple dissertation on the theory and practice of rendering boiler feedwater fit for use. The text is divided into five sections of varying length, which are: Natural water supplies and their characteristics; Scale formation, its effects, and various chemical means and mechanical accessories by which it may

be prevented; Corrosion, its meaning and means for preventing its attack: Foaming and priming and its causes and prevention (including blow-down control and water de-oiling); Analysis and routine testing, covering all apparatus and methods. The appendix details the necessary standard solutions and reagents, and gives conversion tables and factors. From this reviewer's experience, this book in the hands of the right man might well lead to an understanding of proper feedwater treatment, and increased boiler efficiency might well result.

TAPPI Report

Technical Association Papers. Papers and Addresses presented before the Technical Assn. of the Pulp and Paper Industry. Nineteenth Series. Edited by *Ronald G. Macdonald,* Sec. Published by the Technical Assn. of the Pulp and Paper Industry, New York City. 495 pp. Price, $6.

GATHERED in one volume, and printed readably on a stock that will wear well, are the entire proceedings of TAPPI for the calendar year 1935-36. Both the Fall meeting at Atlantic City and the Annual Meeting at the Waldorf are presented in detail. This includes a transcript of the general sessions; the presentation of each meeting and the papers presented thereat; and adequate reporting of the discussions which followed each paper. The volume as a whole constitutes a thorough review of the year's work of the industry by some seventy odd men, and a contribution to technical literature equalled only by previous volumes in the series. Members of the TAPPI have really no need of this review. It is rather the rest of us, in fields near and far related to pulp and paper, that this note is directed as an indication that here is a volume well worth investigation.

Recent British Books

Chemical Industries, 1936. Edited by *D. M. Newitt.* Published by Leonard Hill, Ltd., London. 381 pages.

ATTRACTIVELY bound in cloth, this new catalog contains much useful chemical and chemical engineering data, and in addition serves as a handy guidebook to the British chemical and equipment manufacturers. A tabular index divides the subject matter into ten sections which include information on both process equipment and chemical products. The book is designed to serve as a practical aid to the chemical manufacturer and chemical engineer.

The Chemists' Year Book, 1936. Founded by F. W. Atack. Edited by E. Hope. Published by Sherratt & Hughes, Manchester, England. Exclusive American agents, Chemical Publishing Co. of N. Y., Inc. 1,257 pages. Price, $6.

Chemists' Pocket Book, 9th Edition. By *Thomas Bayley.* Edited by Robert Ensoll. Published by E. & F. N. Spon, Ltd., London. Exclusive American agents, Chemical Publishing Co. of N. Y., Inc. 460 pages. Price, $3.50.

WELL established in England, these two handbooks may not be so familiar to the American chemist. Their outstanding feature, as compared with the chemical handbooks published in this country, is the relatively large amount of space devoted to methods of chemical analysis, both qualitative and quantitative, and to tables of specification standards for a large number of common chemical products.

New Textbooks

Fundamentals of Qualitative Chemical Analysis. By *Roy K. McAlpine* and *Byron A. Soule.* Published by D. Van Nostrand Co., Inc., New York City. 324 pages. Price, $2.40.

WRITTEN particularly for use in an elementary course in qualitative analysis, this new work is not to be confused with the same authors' earlier book based upon the text of Prescott and Johnson's *Qualitative Chemical Analysis.* The early system of encyclopedic presentation of the elements has been abandoned for a method which considers collectively the members of each analytical group. In this way the similarity and inter-relation of the characteristics of each element in a group are brought out more clearly. While not as extensive nor inclusive as the Prescott and Johnson text, the book represents a commendable forward stride in teaching methods used in elementary qualitative analysis.

Inorganic Chemistry for Colleges. Second Edition. By *William Foster.* Published by D. Van Nostrand Co., Inc., New York City. 925 pages. Price, $3.90.

AN ENTIRE chapter in this new edition is devoted to the subject of atomic structure. Outstanding among its contents are a modified Bohr-Thomsen Periodic Table, the electron theory of valence, the main facts concerning heavy hydrogen, a discussion of the transmutation of the elements, and a brief statement of the quantum theory. The chapters on ionization have been modernized, and the new definitions of acid and base are given.

GOVERNMENT PUBLICATIONS

Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated pamphlet is free and should be ordered from bureau responsible for its issue.

Animal and Vegetable Fats and Oils. Bureau of the Census unnumbered pamphlet; 5 cents. Production, consumption, imports, exports and stocks, quarterly for calendar years 1931 to 1935.

Fats and Oils, and the Excise Taxes of 1936. Bureau of Agricultural Economics; mimeographed.

Transit and Storage Diseases of Fruits and Vegetables as Affected by Initial Carbon Dioxide Treatments, by Charles Brooks and others. Department of Agriculture Technical Bulletin 519; 5 cents.

Colloid Chemistry of Cellulosic Materials, by Alfred J. Stamm. Department of Agriculture Miscellaneous Publication 240; 10 cents.

Notice of Modification of the United States Standards for Rosin and Promulgation of the Modified Standards. Department of Agriculture Miscellaneous Circular No. 22, Supplement 7.

Variations in Naval-Stores Yields Associated with Weather and Specific Days Between Chippings, by V. L. Harper and Lenthall Wyman. Department of Agriculture Technical Bulletin 510; 5 cents.

Naval Stores Report. Bureau of Chemistry and Soils; mimeographed. Annual Report 1935-36 on production, distribution, consumption, and stocks of turpentine and rosin of the U. S. by crop years.

Reciprocal Trade: A current Bibliography. Tariff Commission; mimeographed.

Concessions Granted by the United States in the Trade Agreement With Canada. Tariff Commission; mimeographed. A 639 page supplement to Tariff Commission Second Series Report No. 111, containing digests of trade data respecting the products affected by the concessions.

Calcium Cyanide Dust in Ship Fumigation, by C. L. Williams. Public Health Service Reprint 1728; 5 cents.

Microscopic Appearance of Experimentally Produced Dust Nodules in Peritoneum, by J. W. Miller and R. R. Sayers. Public Health Service Reprint 1717; 5 cents.

Place of Mental Hygiene in Federal Health Program, by Walter L. Treadway. Public Health Service Reprint 1731; 5 cents.

Further Studies of Effect of Radium Upon Bacteria, by R. R. Spencer. Public Health Service Reprint 1726; 5 cents.

Report of National Academy of Sciences, 1934-35.

Publications of the United States Geological Survey, revised to March, 1936.

Directory of Byproduct Coke Plants in the United States, June 15, 1936. Bureau of Mines; mimeographed.

Directory of Beehive Coke Plants in the United States That Produced Coke in 1935. Bureau of Mines; mimeographed.

Bureau of Mines Analyses Talco, Texas, Crude Oil. Bureau of Mines Release July 21, 1936; mimeographed.

Concentration of Copper Ores in North America, by Thomas G. Chapman. Bureau of Mines Bulletin 392; 15 cents.

Microscopic Structure and Concentrability of the Important Iron Ores of the United States. Bureau of Mines Bulletin 391; 20 cents.

Annual Report of the Metallurgical Division, Fiscal Year 1935, by R. S. Dean. Bureau of Mines Report of Investigations 3306; mimeographed.

Ringelmann Smoke Chart, by Rudolf Kudlich. Bureau of Mines Information Circular 6888; mimeographed.

Mineral Production Statistics for 1935—preliminary mimeographed statements from Bureau of Mines on: Abrasive materials; lead and zinc pigments and zinc salts; pig iron and ferro-alloy industries; aluminum salts; phosphate rock; salt, bromine, calcium chloride, and iodine; road oil; feldspar; fuller's earth; natural sodium compounds; talc and ground soapstone; manganese; barite and barium.

Your Plant NOTEBOOK

Partial Pressure Chart for Steam Distillation

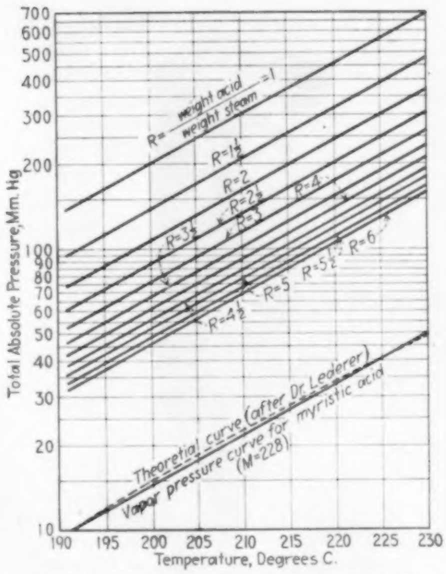
By Chesman A. Lee
Darling & Co.
Chicago, Ill.

MANY organic compounds are distilled at reduced temperatures, aided by the partial-pressure effect of water vapor. In general there are two methods:

1. In the first method, the organic liquid is boiled in contact with the liquid water and the vapors pass off approximately in molal ratio to the respective vapor pressures at the temperature used. The temperature must be such that the sum of the vapor pressures will exceed the absolute pressure above the surface, with sufficient margin to develop the desired distilling speed. In some cases the heat is furnished by "open" steam blown into the batch and allowed to condense within the still.

2. In the second method there is no liquid water and the temperature is maintained too high to permit its formation through the condensation of steam. It is then possible to add steam in any ratio desired. External heat is required and superheated steam is used. In this case the partial pressure of the steam is not limited by the vapor pressure of water at the temperature used, but depends entirely upon its molal ratio in the vapors. Vapor pressure of the material plus partial pressure of the steam must exceed the absolute pressure above the surface as in the first case, but now the partial pressure of the steam is adjustable, permitting independent variations in temperature and pressure.

It is easy to figure the equilibrium weight ratio of the components in the vapor using the standard equation: $\frac{W_A}{W_B} = \frac{P_A M_A}{P_B M_B}$ where W_A and W_B = the weights and P_A and P_B = the partial pressures of components A and B in the vapors; and M_A and M_B = their respective molecular weights. The only assumption is that Dalton's Law applies.



Sample partial pressure chart drawn for myristic acid

In the preliminary design and selection of equipment it is convenient to have charts solving this equation. For the first case discussed above, curves have been given for various liquids by Badger and McCabe in "Elements of Chemical Engineering," p. 338 (First Ed., McGraw-Hill, 1931). Also Baker and Pettibone (*Ind. Eng. Chem.*, **21**, 1929, p. 562) have presented a method for constructing charts based on Dühring's Rule.

It is the purpose of the present article to show how charts may easily be constructed for the second case.

Let P equal the total pressure above the surface and P_A and M_A the vapor pressure and molecular weight, respectively, of the material being distilled If the ratio of material to steam, W_A/W_B, is written as R, then the standard equation may be put in the form:

$$R = \frac{P_A M_A}{(P-P_A)\,18}$$

$$\text{or } P = \frac{P_A M_A}{18R} + P_A = \left(\frac{M_A}{18R}+1\right) P_A$$

By means of the last equation it is easy to determine the total absolute pressure in the still produced with any particular temperature and any desired ratio of material to steam. It can be used most conveniently by making a plot of P vs. temperature for several values of R. A plot on semi-log paper will be preferable for then the curves will be more nearly straight. A sample of such a plot, drawn for myristic acid, is shown in the accompanying chart. It is first necessary to plot the vapor pressure curve of the pure material ($R = \infty$) and as this will generally have more or less curvature, several points, to be secured from the literature, will ordinarily be required. Then as many R curves as necessary can be drawn, first using the equation to calculate the several total pressures corresponding to a particular temperature on the chart, then drawing the R curves through these total pressure points, parallel to the vapor pressure curve.

The data of the sample chart are from the Landolt-Börnstein tables and in this case fit a straight line through the given range. This has simplified the construction to some extent, although it is hardly more difficult when the vapor pressure curve is not straight, since the R curves can readily be drawn parallel to it, by tracing or using dividers. With sufficient data the temperature scale may be distorted to fit a straight line if this seems desirable.

The construction and application of this chart to a practical case will be obvious to anyone with such a problem.

Carboys as Receivers for Semi-Plant Work

By C. T. Weiler
Pennsylvania Salt Mfg. Co.
Philadelphia, Pa.

CARBOYS of the so-called 12-gal. size are used almost exclusively for small shipments of sulphuric, hydrochloric and nitric acids and are readily available in most plants making heavy chemicals. Such carboys are convenient for use as feed and receiving tanks for many sorts of research and development projects, often saving the cost of expensive equipment. Whether or not the 12-gal. size was chosen because of a particular property of this volume is not known, but it is a fact not realized by most people, and useful when carboys are to be used, that the full weight of the contents of this container is approximately equal to the specific gravity of the liquid × 100. Thus, a carboy full of 1.16 sp. gr. HCl (20 deg. Bé.) contains very nearly 116 lb. of the acid.

News of EQUIPMENT

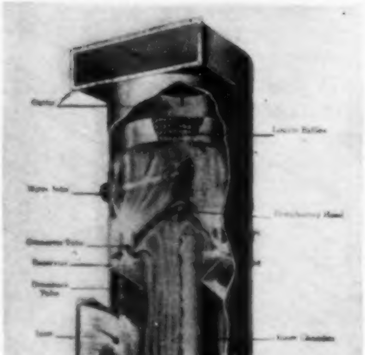
Severe Service Pump

A new design of centrifugal pump intended for the handling of acids, alkalis, brine, other corrosive liquids and hot and cold water has been introduced under the designation "VS" by the Lawrence Pump & Engine Co., P. O. Box 70, Lawrence, Mass. These pumps are produced in a variety of styles to meet different service requirements, being provided with either open or closed impellers, glands for either grease or water sealing and built in whatever construction material may be necessary. The long impeller shaft is supported on two outboard bearings which may be either babbitt-lined or of anti-friction construction. The casing is of the vertical split type for ready accessibility. The stuffing box is extra deep with at least eight rings of packing. For evaporator service, the pump is provided with this company's type of pot seal.

Cyclone Gas Washer

Blaw-Knox Co., Pittsburgh, Pa., has announced the development of a combined cyclone and gas washer which in a single unit subjects any dusty gas stream first to a primary cyclone separation, and then to washing in a device employing the Blaw-Knox contactor tube principle.

Operation of the equipment will be clear from a study of the accompanying cutaway view. The dust-laden air enters tangentially through the inlet, coming in contact with water-wetted walls and depositing the larger dust particles through centrifugal action, then sweeping upward through the inner chamber. The air strikes a cone-shaped partition, is deflected downward over the surface of water in a reservoir, then passes upward at high velocity through a number of contactor tubes. Water from the reservoir is swept upward through the tubes in a fine spray, wetting the dust particles so that when the liquid droplets fall out of the air stream in the upper chamber they carry the dust particles with them. Any entrained moisture is removed from the



Cutaway view of combined cyclone and gas washer

air as it passes through the louvre baffle section placed below the outlet.

Water is supplied through a number of distributor pipes to the reservoir from which it is swept upward through the contactor tubes. From the upper chamber the water flows downward through a number of drainback tubes which distribute it over the cyclone walls. It continues downward into the bottom section, carrying the dirt with it, and is removed from the bottom outlet. Provision is made for periodic flushing of the reservoir section and a gage glass is provided for maintaining the proper reservoir level.

Fibrous Glass Properties

Corning Glass Works, Corning, N. Y., which at the time of the Chemical Exposition in 1935 announced the development of fibrous glass for insulation and glass fabrics, has recently released information on certain of the properties and characteristics of this material. The individual fibers are made in diameters ranging from 1/7 to 1/50 the size of a human hair. In the insulating grade, the fibers have a length about six times as long as that found in any other commercially available insulating material, a property which, combined with natural resiliency, is said to yield a material of extremely light weight in the form of felted bats or strips which will not settle even under extreme conditions of vibration.

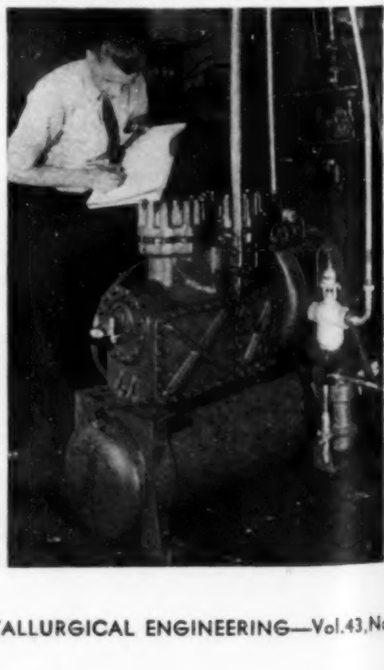
For building insulation the bat form weighs $1\frac{1}{2}$ lb. per cubic foot and the nodulated form, 2 lb. per cubic foot. A special composition for Navy requirements weighs only $1\frac{1}{4}$ lb. per cubic foot. The thermal conductivity coefficient for the $1\frac{1}{2}$-lb. grade is 0.266 B. t. u. per square foot, deg. F., hour and inch of thickness at 70 deg. F. mean temperature. For higher temperature ranges an insulation of 6 lb. per cubic foot density has a coefficient of about 0.60.

The material has been suggested for use also as electrical insulation owing to its inorganic nature and long-time stability; and for various chemical uses in the form of acid filters, gaskets, packing materials and diaphragms. It is expected that the material can be twisted into yarns and woven on standard textile machinery. So far, yarns ranging from $2\frac{1}{2}$ to 45 grains per yard have been made successfully.

Compact Condensing Unit

Hermetically sealed condensing units for air conditioning service, having many new features, have been developed and announced by the Westinghouse Electric & Mfg. Co., East Springfield, Mass. The new units have been given the designation Type CLS, and their outstanding feature is that they are completely inclosed, without seal or stuffing-box between the driving motor and compressor. Each unit comprises a two-, four- or six-cylinder compressor direct connected to a fully inclosed,

Hermetically sealed condensing unit



water-cooled motor, positively lubricated by means of a simple oil pump and provided with integrally cast intake and exhaust manifolds. There is only one external pipe and this connects with a shell and coil condenser provided with two coils which may, by means of a simple change, be connected either in series or in parallel, depending on whether the cooling medium is city water or water from a cooling tower.

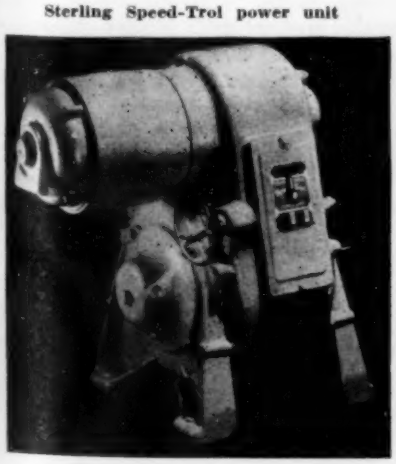
This type of construction is said to result in lighter weight, less maintenance and a smaller floor space requirement than is customary in conventional designs. The new line is produced in nominal ratings from 7 to 22 tons of refrigerating capacity.

Variable Speed Unit

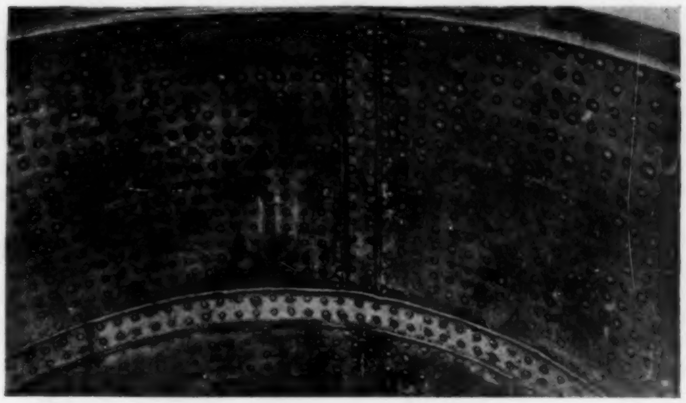
In our issue of April, 1933, we announced the first of a series of motorized variable speed units developed by Sterling Electric Motors, Inc., Telegraph Rd. at Atlantic Blvd., Los Angeles, Calif. The company now announces that it has developed a completely redesigned line, which has been given the name of Speed-Trol unit. From the illustration it will be clear that this unit is provided with a universal mounting feature in that the housing may be rotated around the base in any one of five positions. The design has been simplified and efficiency has been increased by the use of wider cone-pulley angles. Belts of greater cross section are employed and an improved form of speed ratio indicator used. Lubrication is more readily accomplished.

It will be recalled that this device consists of an integral motor driving a pair of variable diameter cone pulleys connected by a V belt. Both pulley diameters are positively controlled by means of a hand wheel or, alternatively, the unit may be arranged for remote electrical or mechanical control. Ratings for the Speed-Trol range from $\frac{1}{4}$ to 15 hp., for speed variations ranging from 2:1 to 6:1.

Sterling Speed-Trol power unit

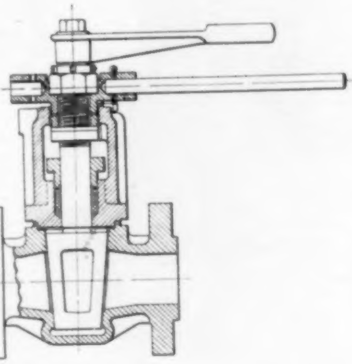


Thirty Thousand Holes Without a Leak
Portion of stainless steel lining for cracking plant dephlegmator, attached by 30,000 9/32-in. holes welded up inside the dephlegmator with special 18-8 arc welding electrodes; job done by La Consolidada, S. A., Mexico, D. F.; in seven months service has shown no leakage. (Courtesy Lincoln Electric Co.)



Unseating Plug Valve

A new valve incorporating in its design positive mechanical seating and unseating, known as the two-handle lift-type plug valve, has been developed by the Homestead Valve Mfg. Co., Coraopolis, Pa. A mechanical leverage is employed to lift the plug vertically from its seat sufficiently to relieve the friction between plug and body and allow free rotation of the plug. By reversing the process the plug is mechanically reseated. To operate this valve from its closed position, the plug is first raised by means of a handle which is part of the lifting mechanism. A positive upward movement is secured through a $\frac{1}{4}$ turn. The plug is then rotated 90 deg. to the new position by means of a second handle. Reseating is then accomplished by turning the lifting handle in the opposite direction.



Two-handle lift-type plug valve

The new valve is designed for pressures of 125 lb. and higher and temperatures up to and including 750 deg. F.

Proportioning Electric Control

Leeds & Northrup Co., 4900 Stenton Ave., Philadelphia, Pa., has recently introduced a new Micromax electric controller for proportioning input to demand. This controller, available for the regulation of any process variable that is detectable by means of a potentiometric instrument, includes three elements, a measuring circuit, a relay detector and a valve mechanism. Two self-balancing circuits are employed, one for measuring the condition being controlled and the other for carrying out the control action. Any unbalance in the measuring circuit unbalances the valve-operating circuit, causing the motor drive to change the valve opening until balance is restored.

The equipment is provided with three adjustments, one for setting the control point, a second for varying the width of the throttling range and a third for correcting manually for deviation from the control point caused by sustained changes in operating conditions.

Dust Collector

American Foundry Equipment Co., 555 Byrkit St., Mishawaka, Ind., has introduced what is called the American Dustube Collector, a design said to be of extreme simplicity. The heart of the new collector is the long filter tube employed, made of especially woven fabric. Tubes are hung from racks in the ceiling, with self-acting dust seals holding them to the bottom, without clamps, bands or intricate devices. The seal is said to be positive. Spring suspension of the tubes maintains proper tension and assists tube replacement. Tubes are said to be easily accessible and replaceable in less than 5 minutes.

New Instruments

Leeds & Northrup Co., 4900 Stenton Ave., Philadelphia, Pa., has recently completed two new instrument developments. One is a speed recorder which employs the familiar Micromax potentiometer recorder for chart drawing and a tachometer magneto, attached to the rotating shaft, to generate an electromotive force proportional to the speed. This is carried by ordinary lead wires to the recorder which automatically balances its own emf. against that of the magneto, recording the result as speed on the chart. The recorder may be placed any desired distance from the detecting mechanism. The other develop-

ment is a new model of the Micromax recorder itself which differs from earlier models in that no mechanism is visible, 10 in. of the strip chart shows and the immediate reading is indicated on a large scale. When control contacts are added a second pointer shows the control setting.

A universal socket dial thermometer in two types has been announced by the Jas. P. Marsh Corp., 2073 Southport Ave., Chicago, Ill. Type 61 is self contained and Type 62 equipped with 6 ft. of connecting tubing. Both types are provided with mountings designed to permit their installation at any desired angle with respect to the equipment. Both thermometers are available in scale ranges from — 20 to 800 deg. F. Having a dial diameter of $3\frac{1}{2}$ in. the scale length is approximately equivalent to that of most 9-in. industrial thermometers of the glass-tube type.

Pyrometer Instrument Co., 103 Lafayette St., New York City, has placed on the market a new combination surface and needle pyrometer provided with interchangeable thermocouples making the instrument convertible into four different types for measuring roll temperature, mold temperature, temperatures of other flat surfaces and temperatures inside various materials in the plastic state.

Two recent developments of the Taylor Instrument Cos., Rochester, N. Y., include a new separable well tube system for thermometers and a new line of indicating controllers for temperature and pressure. The former, known as the Thermospeed, is said to have a speed response closely approaching that of extremely fast bare bulb tube systems. The response of the new system is said to be approximately six times faster than the average separable well tube system now in service. The controllers mentioned are of this company's Fulscope type, operated by air and giving an indication but no record of the control function. Ready setting of the control point and full range adjustability of sensitivity are features of the new instruments.

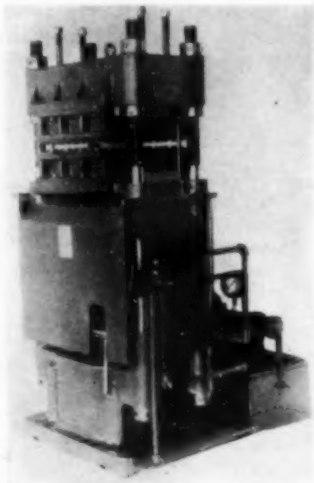
Double Roll Crusher

Quick adjustment of the clearance between the rolls is a feature of the new design of double roll crusher recently developed by the Jeffrey Mfg. Co., Columbus, Ohio. As will be evident from the accompanying illustration, this machine employs a self-contained endless belt drive between the rolls, permitting adjustments to be made within the limits of the sizing range while the machine is running. The crusher is provided with an all-steel frame having heavy steel cross ties.

New adjustable double roll crusher

Self-Contained Press

Four sizes of self-contained molding press in capacities from 50 tons to 300 tons total pressure, for which low first cost and operating cost and high operating speed are claimed, have been announced by the Standard Machinery Co., Mystic, Conn. Hydraulic pressure supplies the force for both closing and opening the press, but through an arrangement of toggles, rather than directly, so that a hydraulic cylinder of reasonable size can be employed, while at the same time the maximum unit hydraulic pressure is held down to 600 lb. per square inch. Pressure for the ram is supplied by a motor-driven rotary pump of two-stage construction controlled by the operator by means of a single-lever, four-way valve.

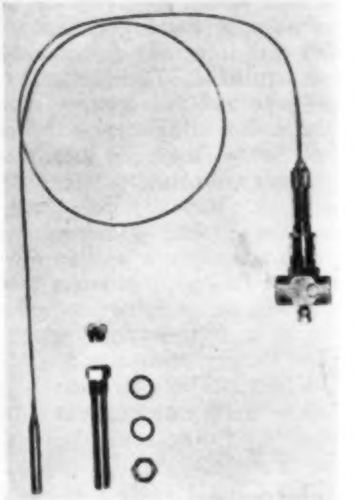


New combination hydraulic and mechanical press

The press closes rapidly under low pressure with both pump stages operating; then as closing approaches completion, at a predetermined pressure the low-pressure stage cuts out and final closing is achieved with the high-pressure stage only. As long as the press is closed, maximum pressure is maintained automatically by means of a relief valve set at 600 lb., discharging to a bypass around the high-pressure stage.

Temperature Controller

An automatic temperature control valve, which introduces the novel feature of being used on the condensate line to discharge condensate, rather than in the inlet steam line of process vessels, has been announced by Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa. The valve is of the throttling type, operated by a thermostatic element of bulb and bellows design. When it is employed in the condensate line, it eliminates steam regulators and steam traps and frequently does away with pressure reducing valves, according to the manufacturer. For small capacity applications, it is sometimes used on the inlet side.



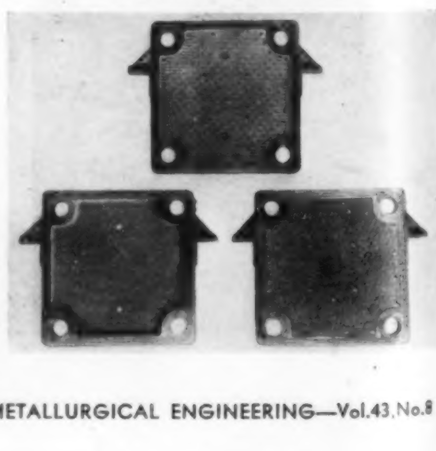
Temperature control valve for process vessels

The new valve is made with a body of cold-rolled steel, and a disk and seat of stainless steel. The one shown in the accompanying view is the $\frac{1}{2}$-in. size for steam pressures up to 125 lb.

High Pressure Filter

For filtration at pressures between 350 and 1,000 lb. per square inch T. Shriver & Co., Harrison, N. J., has developed a line of heavy-duty filter presses with both the filter frame work and the plates and frames of exceptionally rugged construction. A number of different types of filter plate are available for high pressure operation, built in such metals as stainless steel, Monel metal, bronze and electro-galvanized

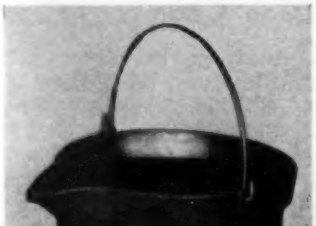
Filter plates designed for high pressure operation



cast iron. As appears from the accompanying illustration, special corrosion resisting screens are fitted over the plate to support the filter cloth at high pressure.

Latex Pail

Dewey & Almy Chemical Co., Cambridge, Mass., has announced the development of the Darex pail, which is cast directly from liquid latex compounded for long life and resistance to corrosive chemical action. The pail is unbreakable and is said to have walls thick enough to prevent appreciable bulging. Reinforcement of the front wall allows the pail to be rested on a narrow edge in pouring while the design of the spout is such as to give accurate control of stream size. Tests are reported to have shown the pail resistant to many chemicals including glacial acetic, commercial hydrochloric, hydrofluoric and 50 deg. sulphuric acids, as well as caustic alkalis.

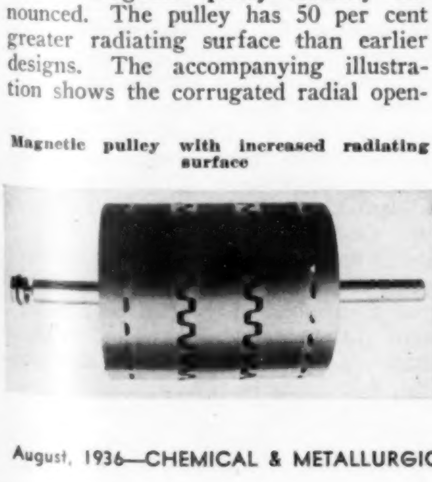


Latex rubber pail for corrosive liquids

Magnetic Pulley

More than 20 per cent greater magnetic pull than has been obtainable either with solid pulleys or with those having different air cooling arrangements is claimed by the Dings Magnetic Separator Co., Milwaukee, Wis., for a new magnetic pulley recently announced. The pulley has 50 per cent greater radiating surface than earlier designs. The accompanying illustration shows the corrugated radial openings centrally located in each magnetic pole. The conveyor belt forces air downward through these openings and out through longitudinal ducts which are also corrugated, thus presenting the maximum amount of radiating surface. Standard equipment with the new pulley includes the necessary set collars, slip rings and contact brushes, collector ring housing, and switching equipment.

Magnetic pulley with increased radiating surface



MANUFACTURERS' LATEST PUBLICATIONS

Alloys. Duraloy Co., Pittsburgh, Pa.—8-page booklet describing this company's alloys of chromium, nickel and iron for abrasion, corrosion and temperature resistance.

Apparatus. Precision Scientific Co., 1736 North Springfield Ave., Chicago, Ill.—Bulletin 151—20 pages on Kjeldahl equipment made by this company.

Belting. E. F. Houghton & Co., 240 West Somerset St., Philadelphia, Pa.—First issue of a new periodical, "Research Illustrated," concerned with this company's leather transmission belting and packing.

Blowers. Roots-Connersville Blower Corp., Connersville, Ind.—Bulletin 21-B18—4 pages on this company's rotary positive and centrifugal blowers for ice plant service.

Burners. W. S. Rockwell Co., 50 Church St., New York City—Bulletin 360—8 pages on standard and special industrial oil burners made by this company.

Cement Equipment. Traylor Engineering & Mfg. Co., Allentown, Pa.—Bulletin 116—22 pages on burning equipment and equipment for heat recovery in portland cement plants.

Compressors. Sullivan Machinery Co., Michigan City, Ind.—Bulletin 88-O—Covers two-stage, air-cooled Unitair stationary compressors; also Bulletin 88-W, describes this company's compressed air aftercoolers.

Dust Handling. Pangborn Corp., Hagerstown, Md.—50-page book, "Industrial Dust Control Through Exhaust Systems," intended for distribution to a limited number of executives and discussing dust problems and their various solutions.

Electrical Equipment. Wagner Electric Corp., 6400 Plymouth Ave., St. Louis, Mo.—Bulletins 180 and 181—Respectively 102 and 70 pages covering distribution transformers and power transformers, the former in sizes to 500 kva., the latter in larger ratings.

Equipment. Curtis Pneumatic Machinery Co., Wellston P.O., St. Louis, Mo.—Bulletin C-27—4-page folder describing briefly various sorts of airpowered cranes and hoists made by this company.

Equipment. Titusville Iron Works Co., Titusville, Pa.—Leaflet describing three pieces of apparatus made by this company, including mixer heads for mixing gases with gases or liquids; U-bend tube tank heaters; and scrubbers for removing entrained liquids from gases and vapors.

Equipment. Worthington Pump & Machinery Corp., Harrison, N. J.—Publications as follows: L-700-B1A, Vertical vacuum pumps; L-711-B2, Horizontal dry vacuum pumps; S-550-B4B, Vertical four-cycle gas engines; S-575-B1, Steam engines for refineries; W-101-B3A, Horizontal duplex piston pumps; W-101-B4B, Horizontal duplex piston pumps; W-101-B6, Duplex steam pump and receiver sets; W-102-B1A, Turret type horizontal duplex piston pumps; W-310-B5, Pressed-steel frame centrifugal pumps; W-321-B4B, Monobloc centrifugal pumps; W-2007, Technical information on Worthite acid-resisting steel alloy.

Flash Drying. Raymond Bros. Impact Pulverizer Co., 1315 North Branch St., Chicago, Ill.—Bulletin 26—8 pages on this company's flash system of drying, a method which includes the kiln mill method as a special case, with information on its application to a wide range of products.

Furnace. Ajax Electric Co., Frankford Ave. and Allen St., Philadelphia, Pa.—Bulletin 103—4-page folder describing this company's new Ajax-Hultgren salt bath furnace for heat-treating; also 4-page reprint of an article describing industrial application of this equipment.

Furnaces. Hevi-Duty Electric Co., Milwaukee, Wis.—Bulletin HD-636—4 pages describing heating element construction employed in this company's electric furnaces.

Furnaces. Harold E. Trent Co., 618 North 54th St., Philadelphia, Pa.—Bulletin TB-26 Preliminary—2 pages describing a new line of high temperature electric furnaces in capacities from 3.5 to 40 kw.

Heaters. Griscom-Russell Co., 285 Madison Ave., New York City—Form 707—4 pages describing this company's G-Fin tube heaters for fuel oils.

Instruments. The Bristol Co., Waterbury, Conn.—Bulletin 457—Describes this company's new Pyrotrol, a safety instrument designed to guard against pilot light failure in gas-fired industrial ovens.

Instruments. Julien P. Friez & Sons, Inc., Baltimore, Md.—Data Sheet 211—Illustrates comparative errors of different types of psychrometers; also Bulletin K, condensed catalog of air-conditioning instruments including controllers, indicators, recorders and accessories.

Level Control. Northern Equipment Co., Erie, Pa.—Form 401—4-page description of the use of Copes double-control boiler-level controls in the plant of the Pennsylvania Sugar Co.

Materials Handling. American Engineering Co., Philadelphia, Pa.—Folder briefly describing this company's ¼-, ½-, and 1-ton monorail hoists and stationary hoists, with data on capacities and ratings.

Materials Handling. Chain Belt Co., Milwaukee, Wis.—Bulletin 268—12-page booklet describing materials handling, storage, batching, mixing and other equipment made by this company for use in glass manufacturing plants.

Microscopy. Bausch & Lomb Optical Co., Rochester, N. Y.—Catalog E-21—28 pages on photomicrographic equipment.

Piping. M. W. Kellogg Co., 225 Broadway, New York City—4-page folder illustrating this company's flexible piping for high temperatures and pressures.

Plating. The Udylite Co., Detroit, Mich.—Folder briefly describing this company's semi-automatic plating machine.

Process Steam. Cochrane Corp., 17th and Allegheny Aves., Philadelphia, Pa.—Looseleaf collection of folders having to do with process steam, including equipment for removing condensate, purifying vapors and gases, relieving steam pressure and controlling liquid level.

Pumps. Byron Jackson Co., Berkeley, Calif.—Bulletin 360-B—12 pages on this company's close-coupled centrifugal pumps, single- and two-stage, with engineering information on sizes and capacities.

Refrigeration. FlakeIce Corp., 36 Furman St., Brooklyn, N. Y.—Bulletin 14—8 pages completely describing construction of the Type BRC Form AP-2708 FlakeIce machine.

Spectrum Analysis. Adam Hilger, Ltd., 98 Kings Road, Camden Road, London, S.W. 1, England—76-page technical discussion of spectrum analysis with the carbon arc cathode layer.

Steam Traps. Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa.—Circular T-1732—4 pages describing very completely operating principle of this company's "Impulse" steam trap; also bulletin T-1721, folder describing the trap and its applications.

Sulphur Cements. Atlas Mineral Products Co., Mertztown, Pa.—16-page booklet describing construction of acidproof tanks of masonry set in the improved sulphur cement recently introduced by this company.

Termites. Research Department, Continental Insurance Co., 80 Maiden Lane, New York City—64-page book reprinting various articles, government and association reports on termites and termite damage prevention, with considerable information on chemical treatment and tests of chemical preventives.

Welding. Lincoln Electric Co., Cleveland, Ohio—Bulletin 411—12 pages on erection of piping with shielded-arc welding.

Chemical Engineering NEWS

Engineering Societies Will Meet Power Show Week

SURPASSING in scope the planning for any of its preceding presentations preparations for the Twelfth National Exposition of Power and Mechanical Engineering are now going forward apace. The Exposition will open on Nov. 30, in Grand Central Palace, New York.

In order that their members may form a part of the audience the American Society of Mechanical Engineers will, as usual, hold their annual meeting in New York during exposition week. Recently the American Society of Refrigerating Engineers announced that they also would hold their meeting in New York at the time of the exposition. Concurrence of these events is a matter of important convenience to the thousands from all over the United States who regularly attend both the exposition and the respective technical meetings.

Early reports on products and equipment which will be seen at the exposition include mention of an improved variable speed transmission available with immediate, remote, manual or automatic speed control. This is said to offer revolutionary advancement in increased production and lower operating costs. Another variable speed transmission, equipped with anti-friction bearings, is recommended as being compact and quiet.

There will be modern dust collecting systems and vacuum cleaning systems which through contrast bring to mind the antiquated broom that, less than two generations ago, "cleaned" our factories. Exhibits of industrial lighting will set a standard for optimum factory illumination. There will be on display an insulation system which provides underground and outdoor insulation for lines carrying superheated or saturated steam, and hot or cold liquids. In machine and product design there will be new evidence of consideration of the psychological effect, upon the worker, of modern trim lines.

At later dates, nearer the time of the exposition, more detailed and comprehensive information on exhibits will be made available. The coming National Exposition of Power and Mechanical Engineering will be the twelfth under the management of the International Exposition Co. Charles F. Roth is again personally in charge.

Cross License Agreement On Oil Cracking Patents

IT IS announced that the Gasoline Products Co. and the Donnelly Process Corp. have entered into a cross license agreement and settlement under which each party has a right to extend to its present and future licensees a license under the cracking patent rights of both parties. The Donnelly Process Corporation has been an early advocate of the so-called "Coil and Quench" type of cracking operation, and its licensees, in carrying out the process under the Donnelly patents, have utilized clean circulation and numerous other inventions covered by patents owned, or being licensed, by the Gasoline Products Company. It is understood that this settlement probably will result in the dismissal of a large number of patent infringement suits, and it is believed that it constitutes a step in simplifying and clarifying the cracking patent situation.

New York Makes Study of Dust Disease Hazards

IN the latter part of July Elmer F. Andrews, State Industrial Commissioner of New York, announced the appointment of an advisory committee on control of silica dust in rock drilling. This committee is to make a comprehensive study of and recommendations on dust collecting and eradicating devices, and rules and regulations for the prevention of dust disease hazards in industry in New York State. The findings and recommendations of the advisory committee will be made to the Industrial Board of the State Department of Labor which will take action upon them relative to their incorporation in the Industrial Code, whereupon, with the approval of the Industrial Commissioner they would become in effect a state law. Appointment of the advisory committee on control of silica dust in rock drilling is but one step taken by the Industrial Commissioner in administering the so-called silicosis legislation enacted by the 1936 Legislature. Similar advisory committees on control of silica and other harmful dust in other industries will be appointed later.

Petroleum Industry Submits Fair Trade Code

THE American Petroleum Institute has submitted to the Federal Trade Commission a "proposed code of rules of fair trade practices" adopted by a petroleum industry conference in Chicago on June 23. C. E. Arnott, chairman of the code committee appointed by the Institute last August, reported that this draft of a proposed code, which was prepared by mid-western refiners, marketers, jobbers, and dealers, had been discussed in meetings held in every state east of the Rocky Mountains and had been circulated throughout the refining and marketing branches of the industry.

A resolution passed by the board of directors of the Institute declared its strong belief in free competition in industry and in ethical marketing practices. It recommended adoption of voluntary rules to achieve these ends through the trade conference system of the Federal Trade Commission in conformity with law. The board also recommended that members of the industry participate constructively in the Federal Trade Commission's trade practice conference when it is held.

Ceramists Will Meet to Discuss Refractories

THE Refractories Division of the American Ceramic Society will hold its summer meeting at Bedford Springs, Pa., on Sept. 4-5. Plant visits are being arranged for the day preceding the meeting. The Bedford Springs Hotel will be headquarters for the technical session which will be held on the afternoon of Sept. 4. Papers will be read by J. D. Keller, research engineer of the Carnegie Institute of Technology and William C. Buell Jr., consulting engineer, Cleveland. To insure full discussion of both papers and of operating experiences in the steel and glass industries a number of people have been asked to prepare discussions. The banquet will be held on the evening of Sept. 4.

Researchers in Welding Field Hold Meeting

THE subcommittee on industrial research of the Engineering Foundation Welding Research Committee held a two-day session, July 23-24, at Watertown Arsenal, Watertown, Mass. Colonel G. F. Jenks, Commanding Officer of the Arsenal and chairman of the subcommittee, presided at the various sessions.

Colonel Jenks stated that the purpose of the conference was to complete the organization of subcommittees preliminary to the analysis of reasearch activities being conducted to solve the many complicated problems in the welding field.

The work was divided among various subcommittees including the following material subcommittees: Cast iron, (chairman not yet named); carbon steels, J. C. Hodge, chairman; low alloy steels, J. H. Critchett, chairman; high alloy steels, T. H. Nelson, chairman; aluminum alloys, G. O. Hoglund, chairman; copper alloys, D. K. Crampton, chairman; nickel alloys, O. B. J. Fraser, chairman.

The two-day session included the presentation of papers and reports on radiography, Monel metal, low alloy steels, and high velocity impact tests. Members of the subcommittee had an opportunity to witness various welding operations at the Arsenal, the centrifugal casting of low alloy steel, and the testing of metals under impact loads delivered at the rate of more than 300 feet a second.

The Lynn Works of the General Electric Co. acted as host to the scientists and engineers and demonstrated the wide applications of welding in the construction of all types of dynamo electric machinery and boilers.

Plaskon Company Acquires Unyte Corporation

MERGING of the business of the Unyte Corporation with that of the Plaskon Company, Inc., was announced on August 5. The new company, which will be the world's largest producer of urea formaldehyde resins, will be known as the Plaskon Company, Inc., a Delaware corporation. Its officers will be those of the Plaskon Company—James L. Rodgers, Jr., president; Horton Spitzer and R. B. Harrison, vice-presidents; C. O. Marshall, secretary, and W. R. Feldtmann, treasurer. Directors will be H. D. Bennett, president of the Toledo Scale Co.; W. P. Pickhardt, former president of Unyte; and J. L. Rodgers, Jr.

This new alignment is the first consolidation in the plastics industry for many years. The new concern takes over all processes and patent rights formerly held by Untye Corp. There will be no public offering of stock. Head offices will be in Toledo, O. The New York office of Unyte formerly at 521 5th Ave., will be transferred to 41 East 42d St. For the present, Unyte will be manufactured and sold under its own name.

Metals Division of A.I.M.E. Will Meet at Cleveland

THE Institute of Metals Division and the Iron and Steel Division of the A.I.M.E. will hold individual technical sessions and a joint round table discussion as a part of the program of National Metals Week in Cleveland during the week of Oct. 19.

Headquarters of the A.I.M.E. division will be at the Statler Hotel. Registration will begin Monday, Oct. 19 and the technical sessions will open Tuesday morning, and continue to and include Oct. 22. All the technical sessions, except those on Wednesday afternoon, will be held at the hotel headquarters. The Wednesday afternoon sessions of both divisions will be at the Cleveland Exposition Auditorium.

On Thursday, both the morning and afternoon sessions will be joint sessions of the two divisions for the presentation of a round table discussion on "Physical Tests of Metals and Their Significance."

Technical meetings of the Institute of Metals Division will include sessions on aging of metals, constitution of alloy systems, and a session on general nonferrous metallurgy. The Iron and Steel Division has scheduled sessions on blast furnace operation, open hearth steel problems, and on X-ray metallography. The joint round table discussion sponsored by both divisions will include papers on stress-strain relations, the yield-tensile ratio, Poisson's ratio and ductility factors, fatigue, the transverse notch bar test, tension impact testing, and the relation of hardness to wear and seizure.

The Joint Dinner of the two Metals Divisions will be held on Wednesday evening, October 21st.

International Meeting on Technical Education

IN accordance with resolutions adopted by the Barcelona Congress in 1934, the next International Congress on Technical Education will be held at Rome, Italy, on Dec. 28-30. The affair is now in the hands of an organizing committee. M. Lomont general-secretary of the Bureau will serve as secretary of the Congress.

Production Management Association Formed

AS a result of an invitation extended several weeks ago by E. E. Finch of the Karl Kiefer Machine Co., a group of production men from companies in the food, drug, distilling, and allied fields met in Cincinnati on July 8-9. The main purpose of the meeting was to give production engineers an opportunity to discuss problems of mutual interest with special reference to those pertaining to manufacturers of packages and to manufacturers who distribute their products in packaged form. At the meeting held on July 9 it was decided to form a permanent organization. This will be known as The National Association of Production Management with the following officers: William M. Bristol, Jr., Bristol-Myers Co., president; H. M. Bowman, Stanco, Inc., vice-president; H. F. Brownell, McKesson and Robbins, treasurer; and F. Zegers, E. R. Squibb & Sons, secretary.

The officers and directors were authorized to draw up a constitution and by-laws and do all the necessary preparatory work for submission to another meeting to be held some time in the fall.

It was the opinion of the group that the association should be limited to representatives of manufacturers of packaged products such as foods, cosmetics, drugs, insecticides, distilled spirits, soaps, specific household products and related industries, and it is its intention to invite representatives of companies of this type who were not present to become members of the association.

Output of Fullers Earth Increased Last Year

PRODUCTION of fullers earth in 1935 amounted to 227,745 short tons valued at $2,230,229 compared with 220,264 short tons valued at $2,085,081 in 1934, an increase of 3.4 per cent in quantity and 7 per cent in value compared with 1934, thus checking a four-year downward trend in output. The average value per ton also rose to $9.79, an increase of 32 cents over that for 1934, according to a report from the U. S. Bureau of Mines.

Nineteen plants in 8 States reported production of fullers earth in 1935. The combined output in 1935 of Florida and Georgia (64 per cent of the total United States production) was slightly less than in 1934, but the value increased. Production in Texas increased in 1935 to 40,925 tons, valued at $391,641, a gain over 1934 of 25 per cent in quantity and 20 per cent in value.

NEWS FROM WASHINGTON

Washington News Bureau
McGraw-Hill Publishing Co.
Paul Wooton, Chief

WITH THE Food and Drug industries watching developments, the law making machinery is at work on a new food and drug bill which it is planned to present to the next session of congress. Senator Copeland of New York has the matter in hand as the author of the defeated measure that died when congress adjourned last June. With him is working Representative Chapman, of Kentucky, who was prominent in the legislative juggling which preceded the death of the latest proposed measure. Senator Copeland is finding plenty to do in the political campaign in his home state of New York, and has been seen at his office in the Senate office building but little since congress closed for the year. Congressman Chapman also is busy with matters political, there being a primary fight on in Kentucky, for which the lawmaker's service is needed.

Meantime the Food and Drugs Administration of the Department of Agriculture, under the direction of Dr. Campbell, is refusing to permit its name to be used in connection with the proposed bill, and is keeping "hands off," according to officials.

Flare-backs from the reciprocal trade agreements made by Uncle Sam with 13 foreign countries, threaten trouble for the administration. Domestic pressure may force abrogation of some of these arrangements, or at least the modification of them so as to meet the situation which appears to have arisen.

Tariff cuts given Belgium, France, Switzerland or other European country under such a trade agreement, it now is seen, also benefit the energetic merchant or industrialist of Nippon, and add materially to the advantage he already has in lower production costs, including the incomparably cheaper wages he pays his workers.

The Nipponese, awake to every possible advantage, have been importing large quantities of modern, labor saving machinery, so that in addition to the low priced labor, they also have the benefit of the latest, up-to-the-minute machinery.

So manifest is this situation that long distance observers are pretty well convinced Japanese rivalry is swiftly becoming a real menace to a variety of domestic industries, including such things as chemicals, machinery, and even iron and steel products of certain types.

In his report to the Manufacturing Chemists Association of America, Charles Belknap, chairman of the executive committee of that organization makes clear the situation from the standpoint of his organization members. He says among other things: "Under these (trade) agreements tariff reductions were made on 36 paragraphs of the chemical schedule of the tariff act. Concessions by foreign countries for the benefit of our chemical exports have been, in comparison, insignificant." Continuing he adds: "The progress of Japan in chemical manufacture has attracted wide attention. After supplying most of her home requirements Japan took over many of the export markets of the Far East."

He also points out that the first domestic competition felt by the United States chemical industry was through the importation of finished articles into which chemicals enter, and he adds that there has been direct competition with a number of low price chemicals from Nippon.

Illustrating this point figures of recent imports show the growth of Japan's rivalry with American chemical industry. In 1935 we purchased 302,000 lb. of sodium ferrocyanide, an increase of 115,000 lb.; 268,251 lb. of chlorinated lime, an increase of 219,630 lb., and 270,200 lb. of transparent cellulose film.

The chemical industry was not alone in feeling the pressure of Japanese rivalry. The textile interests also suffered. We imported 30,041,422 sq.yd. of bleached cotton cloth last year, as against 6,043,800 sq.yd. the year before. Last February we bought 5,831,241 sq.yd. of this product, valued at $335,656.

Rayon importation also showed marked increases, jumping from 405,951 lb. of rayon waste in 1934, to 2,011,114 lb. last year.

Iron and steel products also increased along certain lines. The sale of pipes and tubes went from 12,258 lb. in 1934 to more than 221,000 lb. last year, and wire rope increased from 3,544 lb. in the first year to 281,727 lb. in 1935. Tanks for gas and liquids increased from 2,548 to 6,880.

Japan flouted the old adage anent shipping coals to Newcastle. In 1934 she sent us no cotton seed products, but last year she shipped into the United States 22,353,901 lb. of cotton seed oil cake and meal. Her shoe manufacturers bearded the American lion by shipping into this country 2,339,545 pairs of shoes with fabric uppers.

In reprisal to U. S. Treasury decisions against German export subsidies, the German government has issued a decree providing that the "Aski" marks may not be used for payment of exports to the United States and that private barter transactions with the United States may no longer be approved. "Aski" marks is a term applied to the credits in Germany created by shipping goods into Germany, such credit being used to purchase German commodities.

Samples of barley, wheat, rye and other grains are being tested for their malting properties at the research laboratories of the Grain Division, Bureau of Agricultural Economics, Department of Agriculture, according to an announcement by Dr. D. A. Coleman, in charge of the experiments. It is desired to formulate standards which will reflect suitability for malting purposes.

With manganese, chromium, molybdenum, tungsten, cobalt, nickel, magnesium, aluminum and iron present in the formations near Boulder dam the new electrometallurgical experiment station of the Bureau of Mines at Boulder City hopes to determine the possibilities of low cost production of their alloys when an abundance of cheap power is available.

Work will begin on manganese. An effort will be made to produce high purity metallic manganese by electrolysis from solutions obtained by leaching low grade ores. Experiments on a laboratory scale, conducted at the Reno station, indicate that this method has possibilities. It will be tried out at Boulder on a semi-commercial scale.

Large scale experimentation will be done on domestic chrome ores. Chromite will be smelted electrically in the presence of sulphides of iron and copper in an effort to produce an alloy of unprecedently high grade.

Another set of experiments will be begun in the near future on Utah alunite. Alunite will be treated in electric furnaces. Laboratory-scale tests indicate that often the silica is volatilized that the high-alumina residue is amenable to ordinary aluminum processes. The work will be supervised by Dr. R. S. Dean, chief engineer of the metallurgical division.

The bureau has purchased from the contractors the substantial building which they used as a garage and is installing the furnaces and such other equipment as can be bought with the money available.

As bureau officials believe better results can be obtained by concentrating the electrometallurgical work at one station they have had to report adversely on a proposal to have such an experiment station established at the state college at Pullman, Wash. Another reason for the adverse report is that the bureau already has an experiment station in the state.

Lead and Zinc Pigment Sales in 1935

SALES of all lead and zinc pigments in 1935 registered increases running as high as 46 per cent above 1934, according to a report by the United States Bureau of Mines. The upward trend in lead pigments marked a continuation of that in 1934, while the trend in zinc pigments was a reversal of the downward movement of 1934. The average values received by producers of virtually all pigments declined in 1935, those of zinc falling more than lead. Tonnage increases in sales, however, were sufficiently large to bring about higher total values of all pigments.

Lead pigments as a whole enjoyed their best year since 1930. Sales of white lead, dry and in oil, registered the largest proportionate increase in 1935, but this industry had suffered more severely than the others. Whereas sales of white lead were the highest recorded since 1931, those of red lead were the largest since 1930 and those of litharge were the largest since 1929.

Noteworthy increases of 14 and 46 per cent, respectively, in sales of zinc oxide and leaded zinc oxide, were recorded for 1935, following declines of 12 and 10 per cent, respectively, in the preceding year. Sales of zinc oxide were the largest recorded since 1930 and those of leaded zinc oxide have been exceeded in only two or three years. The average prices for French process zinc oxide were reduced sharply in October, 1935. Lithopone sales were 10 per cent higher in 1935 than in 1934 and were the largest recorded since 1930.

Lithopone producers reported an annual production capacity of 235,000 tons.

Sodium Arsenate Effective As Poison for Locusts

A CAMPAIGN against locusts in Argentina has proven that sodium arsenate is effective in poisoning this pest which is credited with destroying approximately 30 per cent of the country's annual agricultural crop, according to a report from American Trade Commissioner J. D. Walstrom, Buenos Aires.

The Ministry of Agriculture of Argentina has recommended the use of more and larger machines to spray and sprinkle sodium arsenate during the autumn and winter, when the locusts have to cross the desert regions, and again in the spring when they are on their way back south. The Minister is reported to be working on a plan which will establish a central agency to direct future campaigns, the report states.

Many methods have been used in Argentina in combatting the locust plague but so far none have been wholly successful. One of the most common methods has been the erection of sheet metal barriers to divert the locusts into trenches where they can be destroyed.

Excise Taxes and Tariff Rates on Fats and Oils

Excise taxes imposed by Revenue Acts of 1934 and 1936, that will be effective on and after Aug. 21, 1936, and tariff rates established by Tariff Act of 1930, as amended by Presidential proclamation and Trade Agreements up to July 10, 1936.

Fat or oil [1]	Duty [2]	Excise tax on imports into United States [3]
Animal fats and oils—		lb.
Tallow	½¢ lb.	3¢
All other inedible animal oils, fats, or greases n. s. p. f.	20% ad val.	3¢
Fatty acids or salts of above	[4]	3¢
Butter	14¢ lb.	—
Lard	3¢ lb.	—
Oleo oil and oleostearine	1¢ lb.	[5]
Wool grease—		
cont. over 2% f. f. a.	1¢ lb.	[5]
cont. 2% or less f. f. a.	2¢ lb.	[5]
medicinal use	3¢ lb.	[5]
All other edible animal oils, fats, or greases n. s. p. f.	20% ad val.	—
Marine animal and fish oils—		
Herring, menhaden, and sod oils	5¢ gal.	[6] 3¢
Whale (other than sperm) and seal oil	6¢ gal.	[6] 3¢
All other fish and marine animal oils n. s. p. f.	20% ad val.	[6] 3¢
Fatty acids or salts of above	[4]	3¢
Cod-liver and cod oil	Free	—
Sperm oil —		
crude	[7] 2½¢ gal.	—
refined or processed	14¢ gal.	—

Fat or oil [1]	Duty [2]	Excise tax on first domestic processing [8]
Vegetable oils and materials—		lb.
Copra	Free	—
Coconut oil—		
from or produced of materials from the Philippines or any other possession of the U. S.[9]	Free [8]	3¢
other	2¢ lb.	5¢
Palm oil—		
for tin plate	Free [10]	[10]
other	Free [10]	[10] 3¢
Palm nuts or kernels	Free	—
Palm-kernel oil—		
rendered unfit for food	Free	3¢
other	1¢ lb.	3¢
Fatty acids or salts of above oils	[4]	3¢
Babassu nuts	Free [11]	[11]
Babassu oil	Free [11]	[11]
Castor beans	[12] ¼¢ lb.	—
Castor oil	3¢ lb.	—
Corn oil	20% ad val.	—
Cottonseed	½¢ lb.	—
Cottonseed oil	3¢ lb.	—
Croton oil	Free	—
Olive oil—		
weighing with container less than 40 pounds	8¢ lb.	—
rendered unfit for food	Free	—
Peanuts—		
shelled	7¢ lb.	—
not shelled	4½¢ lb.	—
Peanut oil	4¢ lb.	—
Tallow, vegetable	Free	—
Teaseed oil	Free	—

Fat or oil [1]	Duty [2]	Excise tax on imports into United States [3]
Kapok oil	[13]	4½¢
Kapok oil fatty acids or salts	[4]	4½¢
Kapok seed	Free	2¢
Semi-drying—		
Rape oil—		
rendered unfit for food	Free	4½¢
other	6¢ gal.	4½¢
Sesame oil—		
rendered unfit for food	Free	4½¢
other	3¢ lb.	—
Sunflower oil—		
rendered unfit for food	Free	4½¢
other	20% ad val.	4½¢
Fatty acids or salts of above oils	[4]	4½¢
Rapeseed	Free	2¢
Sesame seed	Free	2¢
Sunflower seed	2¢ lb.	—
Drying—		
Hempseed oil	1½¢ lb.	4½¢
Linseed oil	4½¢ lb.	—
Perilla oil	Free	4½¢
Fatty acids or salts of above oils	[4]	4½¢
Hempseed	Free	2¢
Flaxseed	65¢ bu.	—
Perilla seed	Free	2¢
Oiticica	[13]	—
Poppy oil	2¢ lb.	—
Rubberseed oil	[13]	—
Sunflower oil	[13]	—
Soybean oil	3½¢ lb. but not less than 45% ad val.	—
Tung oil	Free	—
Walnut oil	[13]	—
Poppy seed	[14] 16¢ 100 lb.	—
Rubber seed	[13]	—
Soybeans	2¢ lb.	—
Tung nuts	Free	—
Seeds and nuts n. s. p. f. (when oils derived therefrom are free)	Free	—
All other expressed or extracted vegetable oils n. s. p. f.	20% ad val.	—
Nut oil n. s. p. f.	Free	—

[1] Whether or not refined, sulphonated, sulphated, hydrogenated, or otherwise processed. [2] Products entering continental United States from "possessions" of the United States are free of duty. The tariff status of fats and oils, and oil materials produced in Cuba has not been determined at this date (July 1936). [3] In this case "United States" means the States, the Territories Alaska and Hawaii, and the District of Columbia. [4] Specific cases subject to Treasury Decisions as to classification, but probably as follows: fatty acids commercially known by name of specific acid (except oleic acid, that is "red oil"), 25% ad val. Oleic acid and fatty acids not commercially known by name of acid, 20% ad val., but if "foots" or waste unsought, dutiable at 10% ad val. Salts subject to Treasury Decisions, probably 25% ad val. [5] The 3¢ per lb. excise tax on imports of "inedible oils, fats, or greases" would presumably apply to any inedible imports under this classification, and to any imported fatty acids or salts of these items. [6] Does not apply to product of American fisheries. [7] Rate established by Canadian Trade Agreement, effective Jan. 1, 1936. [8] According to a ruling of the Bureau of Internal Revenue, "first domestic processing" means the first use in the United States of the oil or oils in the manufacture or production of an article intended for sale. [9] "Possessions" of the United States include Philippine Islands, and the following designated as "non-contiguous territories," Alaska, Hawaii (including Midway Islands), Puerto Rico, Guam, American Samoa (including Swain Island), Wake Island (radio station), Panama Canal Zone, and Virgin Islands. Hawaii and Alaska are technically designated as "Territories." [10] Bound against change during life of Netherlands Trade Agreement, Feb. 1, 1936. [11] "Bound" free from duty and tax during life of Brazilian Trade Agreement, Jan. 1, 1936. [12] Reduced from one-half cent by Trade Agreement with Brazil, Jan. 1, 1936, and Colombia, May 1, 1936. [13] If ruled to be "vegetable oils" n. s. p. f., a tariff rate of 20% ad val., if "nut oils" n. s. p. f., free of duty. [14] Reduced from 32¢ per 100 lb. Netherlands Trade Agreement Feb. 1, 1936.

Salt, Bromine, Iodine and Calcium Chloride in 1935

SALT produced for sale or use by operators of salt mines, wells, and ponds in the United States in 1935 totaled 7,926,897 short tons valued at $21,088,641, an increase of 4 per cent in quantity but a decrease of 8 per cent in value compared with 1934 (7,612,074 short tons, $22,850,797). The output of evaporated salt in 1935 (2,330,042 tons valued at $14,448,910), representing 29 per cent of the total quantity of salt produced, increased 2 per cent in quantity but decreased 2 per cent in value compared with 1934 (2,281,453 tons, $14,771,502). The salt content (3,837,613 tons) of the brine produced and used by producers in the manufacture of chemicals represented 49 per cent of the total salt output and increased 12 per cent in quantity over 1934 (3,417,439 tons). Rock salt produced (1,759,242 tons valued at $5,085,184), amounting to 22 per cent of the total output, decreased 8 per cent in quantity and 19 per cent in value from 1934 (1,913,182 tons, $6,306,095). The average value of all salt in 1935, $2.66 a short ton, was 34 cents less than in 1934; that of evaporated salt, including pressed blocks from evaporated salt, was $6.20, 28 cents less than in 1934; and that of rock salt was $2.89, 41 cents less than in 1934.

Production of bromine in 1935 amounted to 16,428,533 lb. valued at $3,483,239, an increase of 7 per cent in quantity and 8 per cent in value over 1934 (15,344,290 lb., $3,227,425).

Imports of ethylene dibromide in 1935 amounted to 477,005 lb. valued at $89,810, compared with 649,987 lb. valued at $143,164 imported in 1934. Imports of potassium bromide in 1935 amounted to 8,910 lb. valued at $2,904; in 1934, 4,410 lb. valued at $1,047. There were also imported in 1935 22 lb. of raw bromine valued at $22, 2,000 lb. of sodium bromide valued at $530, and 5,310 lb. of other bromine compounds valued at $8,664.

Production of calcium chloride from natural brines in 1935 was reported as 83,546 short tons valued at $1,039,103, an increase of 9 per cent in quantity but a decrease of 10 per cent in value compared with 1934 (76,719 short tons, $1,153,159).

Imports of calcium chloride in 1935 amounted to 2,003 short tons valued at $26,987, compared with 1,975 short tons valued at $26,271 imported in 1934. Exports in 1935 amounted to 30,735 short tons valued at $525,179, compared with 30,715 tons valued at $566,189 imported in 1934.

The sales of domestic production of iodine in 1935 were 245,696 lb. valued at $248,654, compared with 284,604 lb. valued at $342,957 in 1934, a decrease of 14 per cent in quantity and 27 per cent in value.

Imports of crude iodine amounted to 375,819 lb. valued at $420,793 in 1935, compared with 1,481,123 lb. valued at $2,134,979 in 1934, a decrease of 75 per cent in quantity and 80 per cent in value. All the iodine imported in 1935 was from Chile where it is obtained as a byproduct at nitrate plants.

Naphthalene Used to Make Carbon Black in Germany

GERMANY'S efforts during the past two years to develop a carbon black comparable with the American product are now reported locally to have met with success, according to reports from the American Consul at Frankfort-on-Main, to the Commerce Department's chemical division.

The German product, which is based upon naphthalene, a derivative of coal tar, as a raw material, is now in commercial production and is rapidly displacing American carbon black which formerly supplied practically all of that country's requirements for high grade black pigments, the report states.

During the first five months of the current year Germany's imports of carbon black declined to 2,945 metric tons, compared with 4,763 tons in the corresponding months of 1935, official German statistics show.

It is understood that the recent official restrictions placed upon exports of naphthalene from Germany were instituted at the request of naphthalene carbon black manufacturers who felt that they could not undertake the manufacture of this new synthetic product without first being assured of an adequate supply of domestic raw material, it was stated.

A disadvantage of Germany's new carbon black product, which would be more serious under normal conditions of international trade, is its price, which is considerably above that of high grade imported gas blacks coming from the United States. However, because of conditions now affecting German economy, particularly the severe shortage of foreign exchange which renders it very difficult to negotiate imports, even of vitally needed raw materials, it is felt in that country that relative costs are no longer a decisive factor where national economic independence is concerned.

To insure a market for the high priced domestic naphthalene black the German Government issued a decree some weeks ago requiring tire and other consuming industries to admix 20 per cent of the new product with imported gas blacks for all purposes which require high grade carbon blacks, it was stated.

CALENDAR

AMERICAN CERAMIC SOCIETY, REFRACTORIES DIVISION, summer meeting, Bedford Springs, Pa., Sept. 4-5.

AMERICAN CHEMICAL SOCIETY, semiannual meet, Pittsburgh, Pa. September 7-12.

ELECTROCHEMICAL SOCIETY, semiannual meeting, Niagara Falls, N. Y., October 8-10.

NATIONAL METAL CONGRESS AND EXPOSITION, Cleveland, Oct. 19-23.

SOUTHERN CHEMURGIC CONFERENCE, Lafayette, La., Oct. 15.

AMERICAN PETROLEUM INSTITUTE, annual meeting, Chicago, Ill., November, 9-12.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, annual meeting, Baltimore, Md., November 11-13.

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS, annual meeting, Providence, R. I., December 4-5.

INTERNATIONAL BUREAU FOR TECHNICAL EDUCATION, Rome, Italy, Dec. 28-30.

TECHNICAL ASSOCIATION OF THE PULP & PAPER INDUSTRY, annual meeting, February, 1937.

Manual on Refractories Will Be Prepared

ANNOUNCEMENT is made by the American Refractories Institute of the appointment of Professor A. F. Greaves-Walker as editor-in-chief of a new manual on refractories to be prepared and published under the direction of the Institute. The title of the book will be "Refractories: Their Manufacture, Properties and Uses." It is anticipated that the manual will fill a long felt want in the refractories, metallurgical, chemical, glass and other industries, both in this country and abroad.

The book will cover in detail the history of the industry; the raw materials used; mining and manufacturing practice; properties of refractories; testing of refractories; specifications; the selection, application and uses in the various industries; refractory cements and plastics and general information. A section containing data and tables of general use to both producers and consumers will be included.

It is planned to have the book ready for publication in 1938. Professor Greaves-Walker will be assisted in the preparation of the book by Stuart M. Phelps, Refractories Fellow of the Mellon Institute of Industrial Research, and a group of selected specialists will be contributors.

PERSONALITIES

Robert C. Gunness

Robert C. Gunness has been appointed director of the Boston Field Station of the School of Chemical Engineering Practice of the Massachusetts Institute of Technology. Howard S. Gardner, Jr., received appointment as director of the Bangor, Maine, station and John E. Eberhardt as director of the Buffalo station.

Dr. Gunness, a native of Amherst, Mass., and a graduate of Massachusetts State College in 1932, was awarded his master's degree in chemical engineering practice at the Institute in 1934 and his doctorate in science this year.

Mr. Gardner received his master's degree from the Institute in 1931. He then joined the Eastman Kodak Co. as chemical engineer and has been active in engineering developments.

Dr. Eberhardt graduated from the University of Cincinnati in 1933. He entered the Institute in that year and acted as assistant director of the Buffalo station.

Leo Hendrik Baekeland, on July 10, was presented with honorary membership in the Royal Society of Edinburgh, Scotland. The Society is an old institution, founded in 1783. Its members consist of those who have distinguished themselves in scientific achievement. Prof. James Kendall was recently elected secretary of the Royal Society. He is well known to American chemists and chemical engineers.

J. L. Homerton has been transferred from the Anniston, Ala., plant of the Monsanto Chemical Works to the Monsanto, Ill., plant. He is a member of the technical staff.

Henry L. Coles, professor and head of the department of chemical engineering at the University of Detroit, has accepted a similar position at the University of Colorado.

Herman Schneider, president-emeritus of the University of Cincinnati, was awarded the Lamme Medal for achievement in engineering education at the annual dinner of the Society for the Promotion of Engineering Education. This award is made annually to a technical teacher for outstanding accomplishment in his profession or for actual advancement of the art of technical training. It was originated by Benjamin G. Lamme, late chief engineer of the Westinghouse Electric & Mfg. Co.

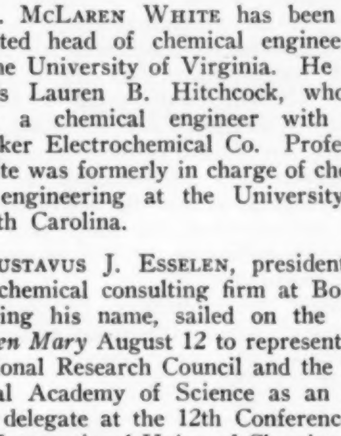
Dr. C. E. P. Jeffreys, California Institute of Technology, has been appointed research chemist and bacteriologist of the Truesdail Laboratories, Inc., Los Angeles. Dr. Jeffreys is one of the abstractors of *Chemical Abstracts*.

A. McLaren White has been appointed head of chemical engineering at the University of Virginia. He succeeds Lauren B. Hitchcock, who is now a chemical engineer with the Hooker Electrochemical Co. Professor White was formerly in charge of chemical engineering at the University of North Carolina.

Gustavus J. Esselen, president of the chemical consulting firm at Boston bearing his name, sailed on the S.S. *Queen Mary* August 12 to represent the National Research Council and the National Academy of Science as an official delegate at the 12th Conference of the International Union of Chemistry in Lucerne, Switzerland, August 16 to 22.

John W. Andrews, cable engineer and physical chemist for the Western Electric Co. at Kearny, N. J., died suddenly from a heart attack on July 11. Dr. Andrews, an active member of T.A.P.P.I. and Sigma Xi, had graduated from Kansas Agricultural College in 1920 and received his Ph.D. from Illinois in 1924.

John W. Andrews



H. Everard, formerly associated with the Richfield Oil Co. of California, is now connected with the International Bitumen Co., Ltd., Edmonton, Alberta. As refinery engineer he will design and operate a refinery for the production of gasoline, and other products.

Robert L. Taylor, formerly associated with the Sharples Solvents Corp., Wyandotte, Mich., has joined the editorial staff of *Chem. & Met.* Mr. Taylor is a graduate of the chemical engineering department of the University of Michigan and is a former editor of *The Michigan Technic*.

Mahlon G. Milliken, general manager of the cellulose products department of the Hercules Powder Co., has been elected a director of the company. He has been with the Hercules Co. since 1915. Charles A. Bigelow has been elected a vice-president and a member of the executive committee by the board of directors. William R. Ellis, now assistant general manager of the explosives department, was named general manager, taking the place vacated by Mr. Bigelow.

William C. Weber of the Dorr Co., New York, is en route to Japan where he will remain for three or four months in connection with patent and process work relating to the manufacture of chemical fertilizers.

Chemical ECONOMICS

REPORTS on industrial activities throughout July have indicated that manufacturing operations have held up surprisingly well with some industries going ahead of their June rate. According to the Federal Reserve Board, the index for industrial production in June was 104 compared with 105 for the preceding month and with 86 for June last year. The unadjusted index for manufactures was 105 for June which is the same as that reported for May while the adjusted figures show 104 for June and 101 for May.

The silk branch of the textile industry which had made a poor showing in the first half of this year did better than had been anticipated in July with mill takings amounting to 36,658 bales or better than 5000 bales over the June figure. However the July total fell far below that for July, 1935 and for the first seven months of the year a decline of about 16.5 per cent is registered for mill receipts.

Domestic rubber consumption made a new all-time high in June, reaching 52,636 tons. This was the third successive month that United States consumption of crude rubber exceeded 50,000 tons, and only the fourth time in all history that this mark has been exceeded.

Consumption of crude rubber in June was 4.3 per cent above May, but 45.6 per cent above June a year ago, according to the Rubber Manufacturers' Association. Consumption in June, 1935, amounted to 36,156 tons. In May, 1936, it was 50,482 tons, and the previous high was 51,897 tons in April. Thus during the past three months United States consumption of crude rubber totaled 155,115 tons, as compared with 121,504 tons during the corresponding months of last year, an increase of almost 30 per cent.

Sales on paint, varnish, and lacquer as reported in the accompanying table cover activities of 579 establishments which accounted for about 80 per cent of total sales as reported in the census figures for 1933. Starting in January this year an additional report includes sales of 680 establishments with June sales placed at $40,420,332 and Jan.-June sales at $198,069,838.

Marked gains in total net sales in June compared with those for June, 1935, were reported by manufacturers in a joint study of the National Association of Credit Men and the Bureau of Foreign and Domestic Commerce. Total sales of 543 manufacturers registered an increase of approximately 33 per cent in June over June, 1935. Without adjustment for seasonal influences sales in June this year were more than 3 per cent higher than those for the preceding month.

The number of manufacturing firms which furnish sales data for this report is still too small—although steadily increasing since the study was started last January—to assume that the percentages of increases or declines hold good for the entire industries as specified but they may be taken as indicative of the trends in those industries.

Among the industries included in the report which are associated with chemicals either as producers or consumers are the following:

	Percentage June 1936 from June 1935	Gain of Sales June 1936 from May 1936
Chemicals and allied products	20.6	7.7*
Textiles	20.1	0.7*
Paper products	17.9	5.1
Paints and varnishes	24.5	9.7*
Pharmaceuticals	13.7	3.4
Petroleum products	16.7	3.9
Rubber products	35.3	5.9
Leather and products	8.9	2.6*
Stone, clay and glass	58.4	11.3

* Percentage of decline.

Increased activity in American industry, particularly in polish, paint, varnish, and medicinal fields, is reflected in a 17 per cent increase in imports of chemicals and related products during the first half of the current year, according to the Commerce Department's Chemical Division.

This increase was due almost entirely to heavier receipts, coupled in some instances with higher prices, of oriental tung, perilla and other drying oils, varnish gums, Brazil wax, Japanese pyrethrum, and other crude and processed materials, the total of which accounted for more than three-quarters of our chemical and related product imports during the 1936 period.

Total value of our imports of chemicals and related products in the first half of 1936 aggregated $76,383,000, compared with $65,120,000 during the corresponding period of last year, according to preliminary statistics.

Imports of paint and varnish drying oils, and seeds from which such oils are expressed, exceeded $21,500,000 during the first half of the year, against receipts of such products valued at around $14,000,000 for the same months of 1935.

Chinese tung oil headed the list with receipts totaling 83,317,000 lb., compared with 53,483,000 lb. in the 1935 period, and the value rose around 145 per cent to a total of $10,300,000. Manchurian perilla oil followed closely, with receipts aggregating 81,170,500 lb., valued at $4,662,000 compared with 39,732,000 lb. valued at $2,427,600 during the first half of 1935.

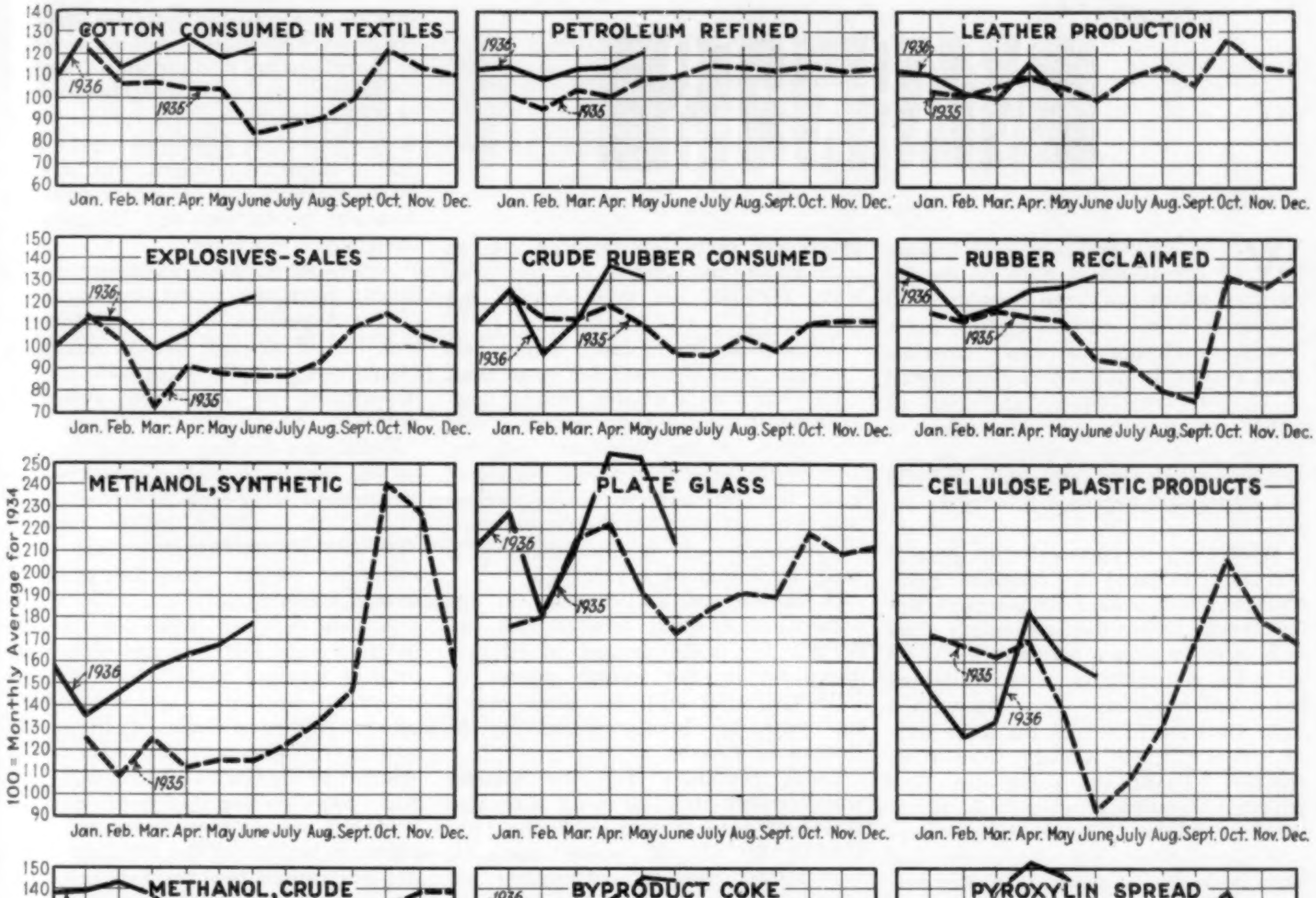
Imports of industrial chemicals, a classification which includes such items as alcohols, acids, camphor, crude glycerine, iodine salts, and potassium and sodium compounds, totaled $9,466,000 in value during the first half of the year compared with $8,262,000 for the corresponding period of 1935.

Production and Consumption Data for Chemical-Consuming Industries

Production	June 1936	June 1935	Jan.-June 1936	Jan.-June 1935	Gain Jan.-June 1936 over Jan.-June 1935 Per cent
Alcohol, denatured, 1,000 wi. gal	7,334	5,585	38,608	35,115	9.9
Ammonia, tons†	58,858	39,877	327,067	253,541	29.0
Automobiles, No	454,487	356,340	2,490,408	2,218,255	12.3
Benzol, 1,000 gal	9,148	5,736	49,890	36,467	36.8
Byproduct coke, 1,000 tons	3,695	2,600	20,622	16,557	24.6
Cellulose acetate plastics, 1,000 lb	1,061	317	5,514	5,029	9.6
Nitrocellulose plastics, 1,000 lb	1,154	909	7,662	7,916	3.2*
Glass containers, 1,000 gr	3,898	3,284	20,812	18,306	13.7
Plate glass, 1,000 sq. ft	16,244	13,163	102,081	87,364	16.8
Methanol, crude, gal	413,930	385,472	2,732,043	2,450,319	11.5
Methanol, synthetic, gal	1,863,405	1,198,186	9,902,190	7,301,811	35.6
Pyroxylin spread, 1,000 lb	4,930	3,274	28,966	25,641	13.0
Rosin, wood, bbl	52,418	47,293	316,442	272,233	16.2
Turpentine, wood, bbl	8,093	6,787	51,753	40,916	26.5
Rubber reclaimed, tons	11,935	8,590	67,394	60,214	11.9
Steel barrels, No	700,667	504,930	3,837,295	3,036,204	26.4
Consumption					
Cotton, 1,000 bales	556	384	3,321	2,835	17.1
Silk, bales	31,437	33,728	205,136	245,368	19.6*
Explosives, sales, 1,000 lb	31,471	22,193	172,179	141,764	21.4
Paint, varnish, and lacquer, sales $1,000	38,664	32,326	190,164	169,946	11.9

* Per cent of decline. † Sulphate equivalent of byproduct coke plant production.

TRENDS OF PRODUCTION AND CONSUMPTION



The MARKETS

WITH REPORTS of a high scale of operations in most of the industries which are large consumers of chemicals, it was natural to look for a steady movement of raw materials from producing points and such proved to be the case. Some falling off in actual consumption of chemicals and related products is anticipated in the present month but prospects for the fall months are regarded as very favorable.

While heavy chemicals in general are not subject to frequent price changes, there was a firmer price undercurrent during the past month. Cresylic acid has been featured for some time by a consuming demand which has taxed productive capacities with a tight situation indicated for some time to come. Prices already have risen sharply. Naval stores likewise have attracted attention because of the rising trend of values. This holds true particularly of rosins for which there has been an increased demand, smaller primary receipts and a low level of prices to start from so that a price reaction was a logical result of increased buying interest in view of the fact that a curtailment in production was assured.

Drought conditions in the West have had a direct bearing on prices for vegetable oils. The domestic flaxseed crop promises to be very small and greater dependence than usual must be placed on Argentine supplies. Soybean and corn oil also have been firmer as a result of weather conditions in producing sections. As new tariffs and processing taxes on imported oils go into effect on August 21, the price trend for oils has been sharply upward.

Mineral acids are more firmly held than has been the case for some time. There has been a notable decline, however, in the amount of sulphuric acid consumed in the fertilizer industry. The fertilizer industry has registered gains this year over the corresponding period of last year but the consumption of sulphuric acid in that industry is well below that of a year ago.

A decline of 26,191 tons in the amount of flaxseed crushed and 16,827,885 lb. in the amount of oil produced during the second quarter of 1936 compared with the same period last year has been reported by the Bureau of Census.

Total crushings for the quarter which ended June 30 were estimated at 144,709 tons of seed producing 110,118,519 lb. of oil, which compares with 170,900 tons of seed crushed and 116,946,404 lb. of oil produced for the corresponding quarter of 1935.

It also was reported that 39 mills crushed soybeans during the second quarter of this year with an output of 56,911,243 lb. of oil as compared with 19,582,025 lb. produced in the comparable period of 1935 when only 21 mills were engaged in crushing soybeans.

Developments in foreign countries as reported by representatives of the Department of Commerce include:

Italy's glycerine industry was nationalized by official decree published in May which placed the country's entire output under supervision of the Commissariat for War Supplies. Saponification plants will be required to ship their entire output of crude glycerine to refining and distilling plants specified by the Commissariat at whose disposal the entire production of distilled or refined glycerine shall be held.

Germany which is one of the largest foreign consumers of American naval stores has further restricted the use of turpentine by requiring wholesalers to limit deliveries to paint stores and painters in order to force the use of domestic substitutes. Previous orders prohibit the use of turpentine in the manufacture of floor and furniture polishes and limit the amount which can be used in shoe and leather polishes.

Recent Spanish legislation provides that 6 per cent of the country's consumption of nitrogen fertilizer shall be produced domestically, and as a result it is anticipated that the initial annual output will be in the neighborhood of 15,000 metric tons. The price, which is expected to be somewhat higher than that of imported nitrogen, will be fixed by the Government. The movement for domestic production was initiated by unemployed workmen.

American chemical exporters should benefit from the recent announcement of the Argentine Minister of Finance that it will amplify present exchange regulations in order to provide for the importation of additional American products.

Germany's leading chemical organization, the I. G. Farbenindustrie, has commenced large-scale manufacture of "Buna," a synthetic rubber product. The cost of production is said to be somewhat higher than the price of natural rubber.

A new nitrogen fertilizer schedule effective from July first and tentatively running for four years which involves reductions averaging approximately 3 per cent on domestic sales of nitrogenous fertilizers in Germany, was recently announced by the German Nitrogen Syndicate. Since coming into power early in 1933, the present government has been active in regulating the fertilizer trade and has caused two previous price reductions, the first of approximately 7 per cent in the spring of 1934, retroactive to July 1, 1933, and the second, of a further 7 per cent, announced in Feb. 1935, retroactive to Dec. 1, 1934, it was stated.

Notwithstanding progressive reductions of Germany's domestic nitrogen prices since 1929, the level still remains far above export quotations. Under the German Nitrogen Cartel setup, exporters selling at lower international prices receive additional compensation from "equalization funds" which are provided from levies on domestic sales.

CHEM. & MET. Weighted Index of CHEMICAL PRICES

Base = 100 for 1927

This month	86.36
Last month	86.21
August, 1935	87.56
August, 1934	87.61

While the majority of important chemicals underwent no price change during the month the undertone of the market was firmer with some selections apparently destined for higher prices in the near future, notably solvents and zinc pigments. Naval stores closed at higher levels.

CHEM. & MET. Weighted Index of Prices for OILS AND FATS

Base = 100 for 1927

This month	90.92
Last month	87.32
August, 1935	85.10
August, 1934	62.97

Prices moved in both directions with net declines in tallow and in china wood oil. The price trend however continued upward with index number of 90.92 comparing with the revised index of 87.32 for the preceding month.

Current PRICES

The following prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to August 14.

Industrial Chemicals

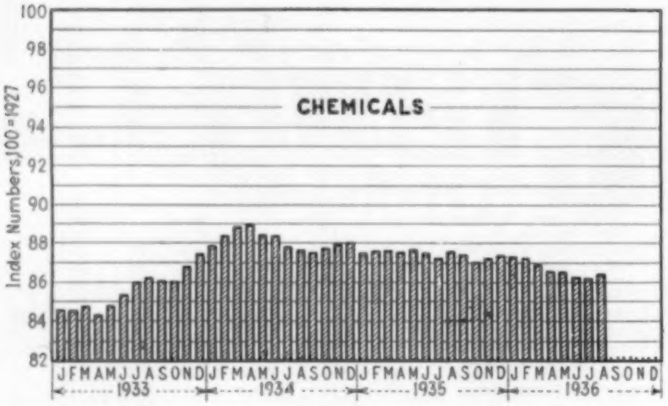
	Current Price	Last Month	Last Year
Acetone, drums, lb	$0.08½–$0.09	$0.08½–$0.10	$0.12–$0.12½
Acid, acetic, 28%, bbl., cwt	2.45 – 2.70	2.45 – 2.70	2.45 – 2.70
Glacial 99%, drums	8.43 – 8.68	8.43 – 8.68	8.43 – 8.68
U. S. P. reagent	10.52 –10.77	10.52 –10.77	10.52 –10.77
Boric, bbl., ton	105.00–115.00	105.00–115.00	105.00–115.00
Citric, kegs, lb	.26 – .29	.27 – .30	.28 – .31
Formic, bbl., ton	.11 – .11½	.11 – .11½	.11 – .11½
Gallic, tech., bbl., lb	.60 – .65	.60 – .65	.60 – .65
Hydrofluoric 30% carb., lb	.07 – .07½	.07 – .07½	.07 – .07½
Lactic, 44%, tech., light, bbl., lb	.11½– .12	.11½– .12	.12 – .12½
Muriatic, 18°, tanks, cwt	1.00 – 1.10	1.00 – 1.10	1.00 – 1.10
Nitric, 36°, carboys, lb	.05 – .05½	.05 – .05½	.05 – .05½
Oleum, tanks, wks., ton	18.50 –20.00	18.50 –......	18.50 –20.00
Oxalic, crystals, bbl., lb	.11¼– .12¼	.11¼– .12¼	.11¼– .12¼
Phosphoric, tech., c'bys., lb	.09 – .10	.09 – .10	.09 – .10
Sulphuric, 60°, tanks, ton	11.00 –11.50	11.00 –11.50	11.00 –11.50
Sulphuric, 66°, tanks, ton	15.50 –......	15.50 –......	15.50 –......
Tannic, tech., bbl., lb	.20 – .30	.23 – .35	.23 – .35
Tartaric, powd., bbl., lb	.24 – .25	.24 – .25	.24 – .25
Tungstic, bbl., lb	1.50 – 1.60	1.50 – 1.60	1.50 – 1.60
Alcohol, Amyl	......–......	......–......	......–......
From Pentane, tanks, lb	14.3 –......	14.3 –......	.15 –......
Alcohol, Butyl, tanks, lb	.08½–......	.08½–......	.13 –......
Alcohol, Ethyl, 190 p'f., bbl., gal	4.27½–......	4.27½–......	4.27½–......
Denatured, 190 proof			
No. 1 special, dr., gal	.34 –......	.34 –......	.36 –......
Alum, ammonia, lump, bbl., lb	.03 – .04	.03 – .04	.03 – .04
Chrome, bbl., lb	.04½– .05	.04½– .05	.04½– .05
Potash, lump, bbl., lb	.03 – .04	.03 – .04	.03 – .04
Aluminum sulphate, com, bags cwt	1.35 – 1.50	1.35 – 1.50	1.35 – 1.50
Iron free, bg., cwt	2.00 – 2.25	2.00 – 2.25	1.90 – 2.00
Aqua ammonia, 26°, drums, lb	.02½– .03	.02½– .03	.02½– .03
tanks, lb	.02½– .02¾	.02½– .02¾	.02½– .02¾
Ammonia, anhydrous, cyl., lb	.15½– .16	.15½– .16	.15½– .16
tanks, lb	.04½–......	.04½–......	.04½–......
Ammonium carbonate, powd. tech., casks, lb	.08 – .12	.08 – .12	.08 – .12
Sulphate, wks., cwt	1.25 –......	1.25 –......	1.20 –......
Amylacetate tech., tanks, lb	.12 – .135	.12 – .135	.142–......
Antimony Oxide, bbl., lb	.12½– .13½	.13 – .14	.10½– .12
Arsenic, white, powd., bbl., lb	.03½– .04	.03½– .04	.03½– .04
Red, powd., kegs, lb	.15½– .16	.15½– .16	.15½– .16
Barium carbonate, bbl., ton	56.50 –58.00	56.50 –58.00	56.50 –58.00
Chloride, bbl., ton	72.00 –74.00	72.00 –74.00	72.00 –74.00
Nitrate, cask, lb	.08½– .09	.08½– .09	.08½– .09
Blanc fixe, dry, bbl., lb	.03½– .04	.03½– .04	.03½– .04
Bleaching powder, f.o.b., wks., drums, cwt	2.00 – 2.10	2.00 – 2.10	1.90 – 2.00
Borax, gran., bags, ton	44.00 –49.00	44.00 –49.00	44.00 –49.00
Bromine, cs., lb	.36 – .38	.36 – .38	.36 – .38
Calcium acetate, bags	2.10 –......	2.10 –......	2.10 –......
Arsenate, dr., lb	.06 – .07	.06 – .07	.06 – .07
Carbide drums, lb	.05 – .06	.05 – .06	.05 – .06
Chloride, fused, dr., del., ton	20.00 –33.00	20.00 –33.00	20.00 –33.00
flake, dr., del., ton	22.00 –35.00	22.00 –35.00	22.00 –35.00
Phosphate, bbl., lb	.07½– .08	.07½– .08	.07½– .08
Carbon bisulphide, drums, lb	.05½– .06	.05½– .06	.05½– .06
Tetrachloride drums, lb	.05¼– .08½	.05¼– .06	.05¼– .06
Chlorine, liquid, tanks, wks., lb	2.15 –......	2.15 –......	2.00 –......
Cylinders	.05½– .06	.05½– .06	.05½– .06
Cobalt oxide, cans, lb	1.41 – 1.51	1.41 – 1.51	1.39 – 1.45
Copperas, bgs., f.o.b., wks., ton	15.00 –16.00	15.00 –16.00	14.00 –15.00

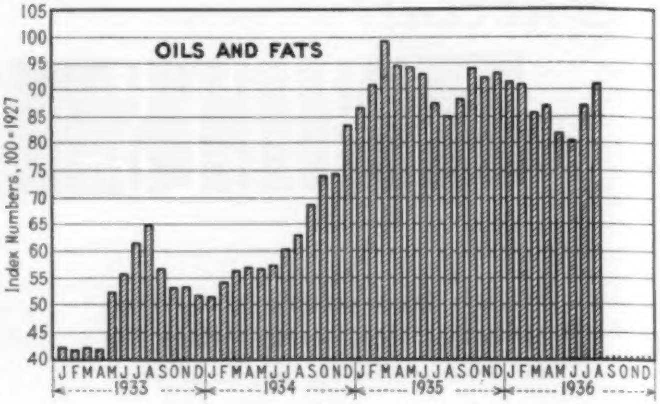
	Current Price	Last Month	Last Year
Copper carbonate, bbl., lb	.08¼– .16	.08½– .16	.08¼– .16
Sulphate, bbl., cwt	4.00 – 4.25	4.00 – 4.25	3.85 – 4.00
Cream of tartar, bbl., lb	.16½– .17	.16½– .17	.16½– .17
Diethylene glycol, dr., lb	.16½– .20½	.16½– .20½	.16½– .20½
Epsom salt, dom., tech., bbl., cwt	1.80 – 2.00	1.80 – 2.00	2.10 – 2.15
Ethyl acetate, drums, lb	.07 –......	.07 –......	.08½–......
Formaldehyde, 40%, bbl., lb	.06 – .07	.06 – .07	.06 – .07
Furfural, dr., lb	.10 – .17½	.10 – .17½	.10 – .17½
Fusel oil, ref. drums, lb	.16 – .18	.16 – .18	.16 – .18
Glaubers salt, bags, cwt	.85 – 1.00	.85 – 1.00	1.00 – 1.10
Glycerine, c.p., drums, extra, lb	.15½–......	.14½– .15	.14 – .14½
Lead:			
White, basic carbonate, dry casks, lb	.06½–......	.06½–......	.06½–......
White, basic sulphate, sck., lb	.06 –......	.06 –......	.06 –......
Red, dry, sck, lb	.07 –......	.07 –......	.06½–......
Lead acetate, white crys., bbl., lb	.10½– .11	.10½– .11	.10½– .11
Lead arsenate, powd., bbl., lb	.09 – .10	.09 – .10	.09 – .10
Lime, chem., bulk, ton	8.50 –......	8.50 –......	8.50 –......
Litharge, pwd., csk., lb	.06 –......	.06 –......	.05½–......
Lithophone, bags, lb	.04½– .05	.04½– .05	.04½– .05
Magnesium carb., tech., bags, lb	.06 – .06½	.06 – .06½	.06 – .06½
Methanol, 95%, tanks, gal	.33 –......	.33 –......	.33 –......
97%, tanks, gal	.34 –......	.34 –......	.34 –......
Synthetic, tanks, gal	.35½–......	.35½–......	.35½–......
Nickel salt, double, bbl., lb	.13 – .13½	.13 – .13½	.12½– .13
Orange mineral, csk., lb	.10 –......	.10 –......	.09½–......
Phosphorus, red, cases, lb	.44 – .45	.44 – .45	.44 – .45
Yellow, cases, lb	.28 – .32	.28 – .32	.28 – .32
Potassium bichromate, casks, lb	.08½– .09	.08½– .09	.07¾– .08¼
Carbonate, 80–85%, calc. csk., lb	.07 – .07¼	.07 – .07¼	.07 – .07¼
Chlorate, powd., lb	.08 – .08¾	.08 – .08¾	.08½– .09
Hydroxide (c'stic potash) dr., lb	.06¼– .06½	.06¼– .06½	.06¼– .06½
Muriate, 80% bgs., ton	23.00 –......	23.00 –......	22.00 –......
Nitrate, bbl., lb	.05½– .06	.05½– .06	.05½– .06
Permanganate, drums, lb	.18½– .19	.18½– .19	.18½– .19
Prussiate, yellow, casks, lb	.18 – .19	.18 – .19	.18 – .19
Sal ammoniac, white, casks, lb	.04½– .05	.04½– .05	.04½– .05
Salsoda, bbl., cwt	1.00 – 1.05	1.00 – 1.05	1.00 – 1.05
Salt cake, bulk, ton	13.00 –15.00	13.00 –15.00	13.00 –15.00
Soda ash, light, 58%, bags, contract, cwt	1.23 –......	1.23 –......	1.23 –......
Dense, bags, cwt	1.25 –......	1.25 –......	1.25 –......
Soda, caustic, 76%, solid, drums, contract, cwt	2.60 – 3.00	2.60 – 3.00	2.60 – 3.00
Acetate, works, bbl., lb	.04¾– .05	.04¾– .05	.04¾– .05
Bicarbonate, bbl., cwt	1.85 – 2.00	1.85 – 2.00	1.85 – 2.00
Bichromate, casks, lb	.06½– .07	.06½– .07	.05¾– .06¼
Bisulphate, bulk, ton	15.00 –16.00	15.00 –16.00	15.00 –16.00
Bisulphite, bbl., lb	.03¾– .04	.03¾– .04	.03 – .04
Chlorate, kegs, lb	.06¼– .06½	.06¼– .06½	.06¼– .06½
Chloride, tech., ton	12.00 –14.75	12.00 –14.75	12.00 –14.75
Cyanide, cases, dom., lb	.15½– .16	.15½– .16	.15½– .16
Fluoride, bbl., lb	.07½– .08	.07½– .08	.07½– .08
Hyposulphite, bbl., cwt	2.40 – 2.50	2.40 – 2.50	2.40 – 2.50
Metasilicate, bbl., cwt	2.75 – 3.00	2.90 – 3.00	3.25 – 3.40
Nitrate, bags, cwt	1.29 –......	1.29 –......	1.275–......
Nitrite, casks, lb	.07½– .08	.07½– .08	.07½– .08
Phosphate, dibasic, bbl., lb	.022– .023	.022– .023	.022– .024
Prussiate, yel. drums, lb	.11½– .12	.11½– .12	.11½– .12
Silicate (40° dr.) wks., cwt	.80 – .85	.80 – .85	.80 – .85
Sulphide, fused, 60–62%, dr., lb	.02¾– .03½	.02¾– .03	.02¾– .03
Sulphite, crys., bbl., lb	.02¼– .02½	.02¼– .02½	.02¼– .02½
Sulphur, crude at mine, bulk, ton	18.00 –......	18.00 –......	18.00 –......
Chloride, dr., lb	.03½– .04	.03½– .04	.03½– .04
Dioxide, cyl., lb	.06½– .08	.06½– .08	.07 – .07½
Flour, bag, cwt	1.60 – 3.00	1.60 – 3.00	1.60 – 3.00
Tin Oxide, bbl., lb	.47 –......	.47 –......	.56 –......
Crystals, bbl., lb	.34 –......	.34 –......	.39 –......
Zinc. chloride, gran., bbl., lb	.05 – .06	.05 – .06	.05 – .06
Carbonate, bbl., lb	.09 – .11	.09 – .11	.09 – .11
Cyanide, dr., lb	.36 – .38	.36 – .38	.36 – .38
Dust, bbl., lb	.068– .07	.069– .07	.063– .07
Zinc oxide, lead free, bag., lb	.05 –......	.05 –......	.05½–......
5% lead sulphate, bags, lb	.04½–......	.04½–......	.05½–......
Sulphate, bbl., cwt	2.65 – 3.00	2.65 – 3.00	2.75 – 3.00

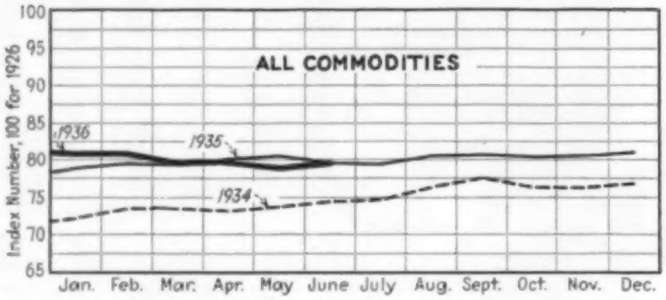
Oils and Fats

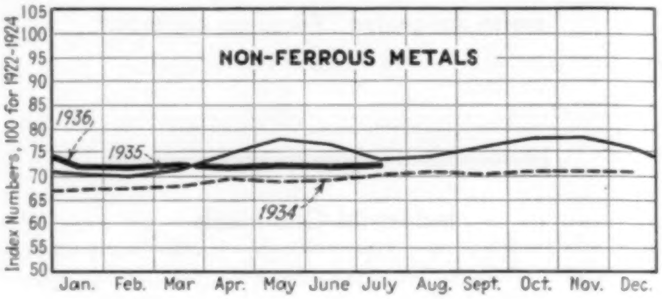
	Current Price	Last Month	Last Year
Castor oil, No. 3, bbl., lb	$0.10 –$0.11	$0.10 –$0.11	$0.09½–$0.10
Chinawood oil, bbl., lb	.16 –......	.19½–......	.15¼–......
Coconut oil, Ceylon, tanks, N. Y. lb	.04¼–......	.04¼–......	.03¾–......
Corn oil crude, tanks, (f.o.b. mill), lb	.09½–......	.08⅞–......	.08¾–......
Cottonseed oil, crude (f.o.b. mill), tanks, lb	.08¾–......	.08¾–......	.08½–......
Linseed oil, raw car lots, bbl., lb	.103–......	.101–......	.089–......
Palm, casks, lb	.04½–......	.04¾–......	.04½–......
Palm kernel, bbl., lb	.05¼–......	.05¾–......	.05½–......
Peanut oil, crude, tanks (mill), lb	.09 –......	.08¾–......	.08¾–......
Rapeseed oil, refined, bbl., gal	.65 –......	.63 –......	.42 –......
Soya bean, tank, lb	.08¼–......	.08¼–......	.08 –......
Sulphur (olive foots), bbl., lb	.08¾–......	.08 –......	.08 –......
Cod, Newfoundland, bbl. gal	.43 –......	.40 –......	.35 –......
Menhaden, light pressed, bbl., lb	.072–......	.06 –......	.065–......
Crude, tanks (f.o.b.factory), gal	.30 –......	.30 –......	.28 –......
Grease, yellow, loose, lb	.05½–......	.05¾–......	.04¾–......
Oleo stearine, lb	.10½–......	.08¾–......	.08¼–......
Red oil, distilled, d.p. bbl., lb	.09⅜–......	.09½–......	.09½–......
Tallow, extra, loose, lb	.06 –......	.05⅞–......	.05⅞–......

CHEM. & MET.'S WEIGHTED PRICE INDEXES









Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-naphthol, crude, bbl., lb.	$0.60 –$0.65	$0.60 –$0.65	$0.60 –$0.62
Refined, bbl., lb.	.80 – .85	.80 – .85	.80 – .85
Alpha-naphthylamine, bbl., lb.	.32 – .34	.32 – .34	.32 – .34
Aniline oil, drums, extra, lb.	.14½– .15	.14½– .15	.14½– .15
Aniline salts, bbl., lb.	.24 – .25	.24 – .25	.24 – .52
Benzaldehyde, U.S.P., dr., lb.	1.10 – 1.25	1.10 – 1.25	1.10 – 1 25
Benzidine base, bbl, lb.	.65 – .67	.65 – .67	.65 – .67
Benzoic acid, U.S.P., kgs., lb.	.48 – .52	.48 – .52	.48 – .52
Benzyl chloride, tech., dr., lb.	.30 – .35	.30 – .35	.30 – .35
Benzol, 90%, tanks, works, gal.	.18 – .20	.18 – .20	.15 – .16
Beta-naphthol, tech., drums, lb.	.24 – .27	.24 – .27	.22 – .24
Cresol, U.S.P., dr., lb.	.10 – .11	.10 – .11	.11 – .11½
Cresylic acid, 99%, dr., wks., gal.	.73 – .75	.68 – .70	.45 – .46
Diethylaniline, dr., lb.	.55 – .58	.55 – .58	.55 – .58
Dinitrophenol, bbl., lb.	.29 – .30	.29 – .30	.29 – .30
Dinitrotoluen, bbl., lb.	.16 – .17	.16 – .17	.16 – .17
Dip oil, 25%, dr., gal.	.23 – .25	.23 – .25	.23 – .25
Diphenylamine, bbl., lb.	.38 – .40	.38 – .40	.38 – .40
H-acid, bbl., lb.	.65 – .70	.65 – .70	.65 – .70
Naphthalene, flake, bbl., lb.	.07 – .07¼	.07 – .07¼	.05½– .06
Nitrobenzene, dr., lb.	.08½– .09	.08½– .09	.08½– .10
Para-nitraniline, bbl., lb.	.51 – .55	.51 – .55	.51 – .55
Phenol, U.S.P., drums, lb.	.14½– .15	.14½– .15	.14½– .15
Picric acid, bbl., lb.	.30 – .40	.30 – .40	.30 – .40
Pyridine, dr., gal.	1.10 – 1.15	1.10 – 1.15	1.10 – 1.15
Resorcinal, tech., kegs, lb.	.65 – .70	.65 – .70	.65 – .70
Salicylic acid, tech., bbl., lb.	.40 – .42	.40 – .42	.40 – .42
Solvent naphtha, w.w., tanks, gal.	.26 –......	.26 –......	.26 –......
Tolidine, bbl., lb.	.88 – .90	.88 – .90	.88 – .90
Toluene, tanks, works, gal.	.30 –......	.30 –......	.30 –......
Xylene, com., tanks, gal.	.30 –......	.30 –......	.30 –......

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grid., white, bbl., ton.	$22.00–$25.00	$22.00–$25.00	$22.00–$25.00
Casein, tech., bbl., lb.	.17 – .18	.15½ – .17	.10½ – .13
China clay, dom., f.o.b. mine, ton	8.00 –20.00	8.00 –20.00	8.00 –20.00
Dry colors:			
Carbon gas, black (wks.), lb.	.04 – .20	.04 – .20	.04 – .20
Prussian blue, bbl., lb.	.37 – .38	.37 – .38	.36½– .37
Ultramarine blue, bbl., lb.	.10 – .26	.10 – .26	.06 – .32
Chrome green, bbl., lb.	.26 – .27	.26 – .27	.26 – .27
Carmine red, tins, lb.	4.00 – 4.40	4.00 – 4.40	4.00 – 4.40
Para toner, lb.	.80 – .85	.80 – .85	.80 – .85
Vermilion, English, bbl., lb.	1.59 – 1.60	1.59 – 1.60	1.52 – 1.56
Chrome yellow, C. P., bbl., lb.	.12 – .14	.12 – .14	.15 – .15½
Feldspar, No. 1 (f.o.b. N.C.), ton.	6.50 – 7.50	6.50 – 7.50	6.50 – 7.50
Graphite, Ceylon, lump, bbl., lb.	.07 – .08½	.07 – .08½	.07 – .08½
Gum copal Congo, bags, lb.	.09 – .10	.09 – .10	.09 – .10
Manila, bags, lb.	.09 – .10	.09 – .10	.16 – .17
Damar, Batavia, cases, lb.	.13½ .16	.15½– .16	.15½– .16
Kauri No. 1 cases, lb.	.19 – .25	.20 – .25	.20 – .25
Kieselguhr (f.o.b. N. Y.), ton.	50.00 –55.00	50.00 –55.00	50.00 –55.00
Magnesite, calc, ton.	50.00 –......	50.00 –......	50.00 –......
Pumice stone, lump, bbl., lb.	.05 – .07	.05 – .08	.05 –...07
Imported, casks, lb.	.03 – .40	.03 – .40	.03 – .35
Rosin, H., bbl.	7.35 –......	6.25 –......	5.05 –......
Turpentine, gal.	.44 –......	.41 –......	.43 –......
Shellac, orange, fine, bags, lb.	.25 –......	.25 –......	.25 –......
Bleached, bonedry, bags, lb.	.18 –......	.18 –	.21 –......
T. N. bags, lb.	.14½–......	.14½–	.14 –......
Soapstone (f.o.b. Vt.), bags, ton.	10.00 –12.00	10.00 –12.00	10.00 –12.00
Talc, 200 mesh (f.o.b. Vt.), ton.	8.00 – 8.50	8.00 – 8.50	8.00 – 8.50
300 mesh (f.o.b. Ga.), ton.	7.50 –10.00	7.50 –10.00	7.50 –11.00
225 mesh (f.o.b. N. Y.), ton.	13.75 –......	13.75 –......	13.75 –......

INDUSTRIAL NOTES

C. J. TAGLIABUE MFG. CO., Brooklyn, N. Y., has promoted A. F. Rucks to the position of general manager. W. C. Bennett has been made general sales manager of the eastern territory and E. D. Wacker, general sales manager for the western territory.

REPUBLIC STEEL CORP., Cleveland, has appointed the Boetticher-Kellogg Co., Evansville, Ind., as jobber of its complete line of tubular products.

STEPHENS-ADAMSON MFG. CO., Aurora, Ill., has appointed F. E. Dunlap as branch manager for the state of Michigan with headquarters in the Book Tower, Detroit.

GENERAL REFRACTORIES CO., Philadelphia, has moved its general offices to the Real Estate Trust Bldg., Broad and Market Sts.

MICHIANA PRODUCTS CORP., Michigan City, Ind., has appointed C. A. Swenson as its representative in Michigan with headquarters at 2842 West Grand Blvd., Detroit.

THE LINCOLN ELECTRIC CO., Cleveland, Ohio, is now represented in Salt Lake City, Utah, by the Industrial Supply Co.

CLAUDE B. SCHNEIBLE CO., Chicago, has placed W. P. Dalrymple, Elma, N. Y., in charge of its sales in the Buffalo territory.

THE COPPUS ENGINEERING CORP., Worcester, Mass., has announced the appointment of the C. W. Cotton Co., Tulsa, Okla., as agents for its complete line in Oklahoma and the Texas Panhandle.

THE PATTERSON FOUNDRY & MACHINE CO., East Liverpool, Ohio, has purchased the ball grinder and mixer business of the A. F. Brown Co., New York.

CROSBY STEAM GAGE & VALVE CO., Boston, Mass., has sold its entire common stock to Carl F. Woods and George F. Felker, president and vice-president, respectively, of the company for the last twelve years.

New CONSTRUCTION

Where Plants Are Being Built in Process Industries

	Current Projects		Cumulative 1936	
	Proposed Work	Contracts	Proposed Work	Contracts
New England........	....	$74,000	$463,000	$806,000
Middle Atlantic......	$148,000	300,000	7,004,000	8,591,000
South...............	276,000	2,973,000	11,708,000	13,825,000
Middle West.........	77,000	1,065,000	6,537,000	5,759,000
West of Mississippi....	300,000	663,000	6,158,000	7,732,000
Far West............	150,000	355,000	4,080,000	5,627,000
Canada..............	1,337,000	300,000	13,505,000	8,337,000
Total............	$2,288,000	$5,730,000	$49,545,000	$50,677,000

PROPOSED WORK

BIDS ASKED

Brass Factory—Mueller Brass Co., Port Huron, Mich., is having plans prepared by Smith, Hinchman & Grylls, Archts., Marquette Bldg., Detroit, Mich., for the construction of a factory on Lapeer Ave. Estimated cost $40,000.

Cement Plant—Universal Atlas Cement Co., subsidiary of U. S. Steel Corp., 208 South La Salle St., Chicago, Ill., plans to construct a cement plant at Hudson, N. Y. A. G. Carlson, c/o Owner, Engr.

Ceramics Plant—H. K. Burns, Loraine, Ga., plans to rebuild ceramics plant of W. S. Dickey Clay Manufacturing Co. at Macon, Ga., recently destroyed by fire.

Distillery — Woodford County Distillery, Earle Fowler, 404 Citizens Bank Bldg., Lexington, Ky., in charge, plans to construct a distillery at Midway, Ky. Estimated cost $90,000.

Factory — Standard Silicate Co., Tonnele Ave. and Thorne St., Jersey City, N. J., contemplates extension to its factory here. Maturity indefinite. Estimated cost including equipment $37,000.

Factory — The Haloid Co., Haloid St., Rochester, N. Y., manufacturer of photographic paper, plans to construct a 2 story addition to its plant here. S. Firestone, 61 South Ave., Rochester, Archt. and Engr.

Laboratory—International Nickel Co., Huntington, W. Va., plans to construct an addition to its laboratory and also an additional 25 ton open hearth furnace.

Paint Factory—Penn Glenn Oil Works, Todd Glenn, Pres., First St., Leechburg, Pa., contemplates the construction of a 1 and 2 story paint factory on First St.

Paper Mill—Great Falls Paper Co., c/o F. E. Flaherty, Vice Pres., Great Falls, Mont., plans to rebuild its paper mill which was recently destroyed by fire.

Pulp Mill—Grays Harbor Pulp & Paper Co., 23rd and Railroad Sts., Hoquiam, Wash., plans to construct an addition to its digester house, screening units, bleaching plant and new filter plant for 10,000,000 gal. water per day. Estimated cost $150,000.

Absorption Plant—Phillips Petroleum Co., Bartlesville, Okla., has had plans prepared by A. H. Riney, Engr., Bartlesville, for the construction of a gasoline absorption plant at Edmond, Okla. Estimated cost $200,000.

Oil Refinery—Old Dutch Refining Co., J. Borden, Pres., Muskegon, Mich., plans to construct an addition to its crude oil refinery. R. B. Lydig, c/o Owner, Archt.

Oil Refinery—Texas Co., 135 East 42nd St., New York, N. Y., plans repairs and alterations to its refinery at Pryse, Ky. Estimated cost $37,000.

Oil Refinery—Wichita Falls Refining Co., c/o Dave Johnson, Wichita Falls, Tex., plans to construct an oil refinery. Estimated cost $60,000.

Sugar Factory—Louisiana State University, Baton Rouge, La., plans to construct additions and improvements to its sugar cane factory here. Weiss, Dreyfous & Seiferth, New Orleans, La., Archts. Estimated cost $75,000.

Beet Sugar Plant—R. B. Pratt, Winnipeg, Man., Can., is preparing plans for the construction of a sugar beet plant at St. Boniface, Man., for Henry Moore Syndicate. Estimated cost $1,300,000.

Soap Factory—Benjamin S. Parker, Winnipeg, Man., Can., is preparing plans for the construction of a soap factory for Northern Soap Co., Ltd.

Laboratory Equipment—Board of Education, Neville Township School Dist., Neville Island, Pa., is receiving bids until Aug. 21 for furnishing chemistry laboratory equipment for school. G. H. Keil, Secy.

CONTRACTS AWARDED

Brick Factory—United Brick & Tile Co., Iola, Kan., has awarded the contract for rebuilding its factory recently destroyed by fire to J. Griffith, Iola. Estimated cost $75,000.

Chemical Factory—Heyden Chemical Corp., Garfield, N. J., has awarded the contract for a 4 story factory to Edward Riehle Co., 85 Delaware Ave., Paterson, N. J.

Distillery—Napa Valley Cooperative Winery, St. Helena, Calif., has awarded the contract for the construction of a distillery to Basalt Rock Co., Napa, Calif. Estimated cost excluding equipment, $17,500.

Distillery—Three-G Distillery Corp., 3112 West San Fernando Blvd., Burbank, Calif., is building a group of distillery buildings including cistern room and fermentation room. Work is being done by day labor and separate contracts under supervision of Bernard Lindberg. Estimated cost $250,000.

Factory—The Carborundum Co., Buffalo Ave., Niagara Falls, N. Y., has awarded the contract for an addition to its factory to Laur & Mack Contracting Co., 1400 College Ave., Niagara Falls. Estimated cost $75,000.

Factory—Dupont Cellophane Co., Inc., Tonawanda, N. Y., is building an addition to its factory on River Rd. Work is being done under the supervision of W. F. Lawless c/o Owners.

Factory—Niagara Smelting Corp., Lewiston Rd., Niagara Falls, N. Y., has awarded the contract for an addition to its factory to W. S. Johnson Building Corp., 2532 Hyde Park Blvd., Niagara Falls.

Factory — Sponge Rubber Products Co., Derby, Conn., has awarded the contract for the construction of a 1 story, 75x130 ft. factory to J. J. Brennan & Sons, 40 Cliff Ave., Shelton, Conn. Estimated cost, $37,000.

Factory—Titanium Pigment Co., subsidiary of National Lead Co., 111 Bway., New York, N. Y., has awarded the contract for two additions to its factory to Wigton-Abbott Corp., 143 Liberty St., New York, N. Y.

Factory—George L. Williams Co., 5700 Train Ave., Cleveland, O., manufacturer of disinfectants, has awarded the contract for an addition to its factory to Superior Construction Co., 15615 Delaware Ave., Cleveland. Estimated cost $25,000.

Gas Plant—City, Union Springs, Ala., has awarded the contract for the construction of a butane-air gas plant to J. B. McCrary Co., Atlanta, Ga., $42,554.

Laboratory—General Motors Corp., General Motors Bldg., Detroit, Mich., has awarded the contract for the construction of a research laboratory on Milwaukee Ave., to O. W. Burke Co., Fisher Bldg., Detroit. Estimated cost $1,000,000.

Laboratory—Merrimac Chemical Co., Chemical Lane, Everett, Mass., has awarded the contract for the construction of a laboratory to W. M. Bailey Co., 88 Broad St., Boston, Mass. Estimated cost will exceed $37,000.

Oil Refinery—Atlantic Refining Co., Franklin, Pa., plans improvements to its gasoline refinery to include Gray unit for cracking, at Franklin, Pa. Work will be done by separate contracts. Estimated cost will exceed $40,000.

Oil Refinery—Central Refiners, Ltd., Brandon, Man., Can., plans improvements to its refinery and storage facilities. Work will be done by separate contracts. Estimated cost will exceed $50,000.

Oil Refinery—Coastal Refineries, Inc., c/o J. L. Sewell, Port Isabel, Tex., is building a vapor rectification unit at its refinery under the supervision of J. Byron Cleveland, O. Estimated cost $50,000.

Oil Refinery—Monsanto Chemical Co., 1700 South Second St., St. Louis, Mo., is building a phosphate refining plant south of Columbia, Tenn., in Maury Co. Work is being done by owner on a sub-contract basis under general direction of R. J. Hawn. J. B. Rutter, General Engineering Dept., Monsanto Chemical Co., St. Louis, Engr. Estimated cost $500,000.

Oil Refinery—Shell Oil Co., Shell Bldg., San Francisco, Calif., has awarded the contract for the construction of an absorption plant on Golden State Hy., Bakersfield, Calif., to Fluor Corp., 1008 West 59th St., Los Angeles, Calif.

Oil Refinery—Texas Co., 135 East 42nd St., New York, N. Y., will construct improvements to its casinghead gasoline plant in the vicinity of Paducah, Tex. Work will be done by separate contracts. Estimated cost will exceed $38,000.

Paper Mill—Union Bag & Paper Corp., Savannah, Ga., has awarded the contract for extensive additions to the kraf tpulp and paper plant to Merritt-Chapman & Scott Corp., 17 Battery Pl., New York, N. Y. Estimated cost $2,750,000.

Pulp and Paper Mill—E. B. Eddy Co., Ltd., C. V. Ceaser, Managing Director, Hull, Que., Can., has awarded the contract for alterations and additions to its mill to Foundation Co. of Canada, Ltd., Montreal, Que., Can. Estimated cost $250,000.

Pottery Plant—Roseville Pottery Co., Zanesville, O., has awarded the contract for the construction of a factory on Linden Ave. to Austin Construction Co., Cleveland. Estimated cost $40,000.

Sugar Refinery—Magnolia Sugar Cooperative Inc., Houma, La., has awarded the contract for an addition to its sugar refinery to Pittman Bros., 2800 North Galvez St., New Orleans, La. Estimated cost $180,000.

Storage Building — Shell Chemical Co., Pittsburg, Calif., has awarded the contract for the construction of a 1 story, 120x182 ft. addition to its ammonium filtrate bulk storage building to Barrett & Hilp, 918 Harrison St., San Francisco. Estimated cost $50,000.

Warehouse—James Distillery, Inc., Key Hy. and Montgomery St., Baltimore, Md., has awarded the contract for the construction of a 5 story warehouse having a capacity of 30,000 bbl. to G. Walter Tovell, Eutaw and Monument Sts., Baltimore.

Larger Byproduct Output From Coke-Ovens in 1935

FINAL statistics for the coke industry in 1935 have been released by the U. S. Bureau of Mines. Total production of byproduct coke is placed at 34,224,053 net tons with a value of $173,271,325. In 1934, byproduct coke production was 30,792,811 net tons valued at $155,545,530, thus indicating that the upward trend in output from the low point reached in 1932 was maintained last year. The declining trend in beehive coke production likewise was maintained as shown by a total volume of 917,208 tons for 1935 compared with 1,028,765 tons for 1934. The number of byproduct plants in existence at the beginning of 1935 was 12,963 which declined to 12,860 by the end of the year, with 122 plants in course of construction. During the same period, the number of beehive plants declined from 14,206 to 13,674 with no data available regarding new construction.

Sales of byproducts obtained from coke-oven operations in 1935 were valued at $101,910,028 as compared with $92,865,828 in 1934. Sales of sulphate of ammonia were prominent among the byproducts both from the standpoint of quantity and sales. In fact sales of sulphate in 1935 were larger than the amount produced, the output being 923,513,235 lb. while sales involved 985,310,831 lb. valued at $9,349,933. Compared with the preceding year, production of sulphate of ammonia in 1935 increased about 17½ per cent while sales were enlarged by more than 26 per cent.

Crude light oil was produced to the extent of 133,696,803 gal. of which 126,688,359 gal. were refined on the premises to produce benzol, toluol, solvent naphtha, xylol, and other light oil products to the amount of 107,540,415 gal. In 1934 production of crude light oil was 115,694,748 gal. of which 108,219,464 gal. were refined to produce 94,570,139 gal. of light oil derivatives. Motor benzol made up more than one-half the total of light oil derivatives in both years, the totals being 58,379,910 gal. in 1935 and 50,046,610 gal. in 1934.

Disposal of Coke-Oven Tar Produced in 1935, in Gallons

	Furnace plants	Other plants
Sold:		
For use as fuel—		
To affiliated corporations	15,245,508	....
To other purchasers	21,991,113	14,024,728
For refining into tar products	134,263,996	123,180,574
Used by producer:		
As fuel under boilers	1,804,683	....
In open-hearth or other metallurgical plants	91,631,693	....
Refined at plant	38,733,459	1,736,334

Sales of crude and refined naphthalene last year amounted to 13,214,108 lb. valued at $167,632. This not only exceeded the 1934 sale of 10,500,285 lb. but also overtopped the 1935 production of 12,937,277 lb. so that reserve stocks were called on in order to meet consuming demand.

Phenol production from coal-tar advanced from 68,609 gal. in 1934 to 94,310 gal. in 1935. As the Bureau of the Census reported a production of 44,934,782 lb. of phenol for 1934, it is evident that production at coke-oven plants is but a small part of the total output.

Production of crude coal-tar in 1935 and 1934 was 450,307,827 gal. and 408,710,314 gal. with sales 308,705,919 gal. and 273,763,739 gal. respectively. In 1935 the amount sold included 51,261,349 gal. for fuel and 257,444,570 gal. for refining into tar products.

Byproducts Obtained From Coke-Oven Operations in 1935 [1]
(Exclusive of screenings or breeze)

Product	Unit	Production	Sales: Quantity	Sales: Value Total	Sales: Value Aver.
Tar	gal.	450,307,827	308,705,919	$12,597,705	$0.041
Ammonia:					
Sulphate	lb.	923,513,235	985,310,831	9,349,933	.009
Ammonia liquor (NH_3 content)	lb.	41,777,575	43,097,903	1,253,181	.029
Sulphate equivalent of all forms	lb.	1,090,623,535	1,157,702,443	....	......
Gas:					
Used under boilers, etc	1000 cu.ft.	[2] 543,396,088	19,788,904	1,300,371	.066
Used in steel or affiliated plants	1000 cu.ft.		160,811,880	15,222,869	.095
Distributed through city mains	1000 cu.ft.		151,255,723	44,510,704	.294
Sold for industrial use	1000 cu.ft.		13,659,750	1,681,104	.123
			345,516,257	62,715,048	.182
Light oil and derivatives:					
Crude light oil	gal.	[3] 133,696,803	12,076,030	1,017,328	.084
Benzol, crude and refined	gal.	20,210,207	20,596,355	2,557,626	.124
Motor benzol	gal.	58,379,910	57,542,312	5,120,881	.089
Toluol, crude and refined	gal.	16,026,438	15,960,968	4,388,728	.275
Solvent naphtha	gal.	3,992,338	3,781,720	644,005	.170
Xylol	gal.	3,695,656	3,747,959	860,891	.230
Other light oil products	gal.	5,235,866	2,426,347	121,718	.050
		[4] 107,540,415	116,131,691	14,711,177	.127
Naphthalene, crude and refined	lb.	12,937,277	13,214,108	167,632	.013
Tar derivatives:					
Creosote oil, distillate as such	gal.	12,579,639	8,125,449	785,265	.090
Creosote oil in coal-tar solution	gal.	932,724	243,104	21,191	.087
Pitch of tar	net tons	112,354	3,129	21,130	6.753
Other tar derivatives	....	....	....	175,055	......
Phenol	gal.	94,310	85,137	26,049	.306
Sodium phenolate	gal.	184,819	167,459	11,016	.066
Other products [5]	....	....	....	125,646	......
Value of all byproducts sold	....	....	....	[6] 101,910,028	......

[1] Includes products of tar distillation conducted by coke-oven operators under same corporate name except, however, phenol and other tar acids produced at Clairton, Pa. [2] Includes gas wasted and gas used for heating retorts. [3] Refined on the premises to make the derived products shown, 126,688,359 gallons. [4] Total gallons of derived products. [5] Ammonia thiocyanate, carbolates, cyanogen sludges, pyridine oil, sodium prussiate, spent soda solution, sulphur, and vented vapors. (6) Exclusive of the value of breeze production, which in 1935 amounted to $5,806,163.

Production and Sales of Coal-Tar Crudes at By-product Coke Plants and Tar Refineries, 1935 [1]

Tar distilled [2]	Oil-gas tar	1,911,650 gallons	$121,101
	Water-gas tar	30,115,339 gallons	1,210,422
	Coal-tar	244,516,809 gallons	10,687,397
	Total	276,543,798 gallons	$12,018,920

	Unit of quantity	Production quantity	Sales: Quantity	Sales: Value	Sales: Unit value
Tar [3]	Gal.	450,307,827	308,705,919	$12,597,705	$0.041
Light oil and derivatives:					
Crude light oil	do	134,070,840	12,327,530	1,052,831	.085
Benzol (except motor benzol)	do	24,106,006	23,029,543	2,975,658	.129
Motor benzol [3]	do	58,379,910	57,542,312	5,120,881	.089
Toluol, crude and refined	do	17,776,551	17,648,286	4,929,219	.279
Solvent naphtha	do	4,970,842	4,742,388	985,124	.208
Xylol [3]	do	3,695,656	3,747,959	860,891	.230
Other light oil products [4]	do	6,812,455	4,005,458	403,785	.101
Naphthalene, crude and refined [5]	Pound	47,653,372	42,017,954	698,088	.017
Creosote oil	Gal.	92,869,152	86,706,628	8,819,335	.102
Tars, crude and refined [2]	do	16,575,539	15,179,905	1,208,093	.080
Tars, road [2]	do	112,038,763	110,612,482	9,253,333	.084
Other distillates	do	15,251,053	7,462,852	1,051,857	.141
Pitch of tar [2]	Ton	436,570	285,542	3,533,576	12.37
Pitch of tar coke [2]	do	80,020	74,970	821,291	10.95

[1] Data for coke ovens reporting to Bureau of Mines, and for tar refineries and others reporting to the United States Tariff Commission, unless otherwise noted.
[2] Reported to the United States Tariff Commission only.
[3] Reported to Bureau of Mines only.
[4] Includes xylol and motor benzol reported to the United States Tariff Commission.
[5] Includes crude and refined naphthalene reported to Bureau of Mines and crude naphthalene reported to the United States Tariff Commission.